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POLICY CAPTURING OF MANAGEMENT PERSONNEL THROUGH PROJECT-SELECT--ETC(U)
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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER (14) AFIT/GSM/SM/79S-1	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) POLICY CAPTURING OF MANAGEMENT PERSONNEL THROUGH PROJECT-SELECTION DECISION MAKING IN AN AIR FORCE RESEARCH AND DEVELOPMENT LABORATORY.		5. TYPE OF REPORT & PERIOD COVERED M. S. Thesis
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) Terry L./Brooks Captain USAF		8. CONTRACT OR GRANT NUMBER(s) (9) Master's thesis,
9. PERFORMING ORGANIZATION NAME AND ADDRESS Air Force Institute of Technology(ATC) AFIT/EN Wright-Patterson AFB, Ohio 45433		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (12) 198
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Institute of Technology(ATC) AFIT/EN Wright-Patterson AFB, Ohio 45433		12. REPORT DATE (11) Sep ~~tember~~ 1979
		13. NUMBER OF PAGES 196
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) LEVEL II		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

DDC RECEIVED NOV 7 1979 E

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES Approved for public release; IAW AFR 190-17

JOSEPH P. HIPPS, Major, USAF
Director of Information

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Organizational Behavior
Behavior Modeling
Decision-Making
Policy Capturing
Goals
Consensus
Delphi Technique

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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The policy capturing instrument was constructed based on six factors that were identified by interviews with the

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laboratory managers. These factors were Cost-Benefit Ratio, Technical Merit, Resource Availability, Likelihood of Success, Time Period, and Air Force Need. The instrument required the managers to make 32 decisions concerning his/her support or non-support of 32 hypothetical R&D projects.

The results were a positive indication of the successful use of policy capturing technique. It was determined that the simple linear model (the 6 additive factors) of the decision process was as representative of the individual managers as the interactive model (the 6 additive factors plus the 15 interactive terms). Therefore, the simple model was used for the data analysis. Technical Merit and Air Force Need accounted for approximately 75 to 80% of individual and group models. The 6.2 project management level models were determined to be the same, whereas the 6.3 project management level models were different. The 6.2 division models were different as were the 6.3 division models. In comparing the management levels and divisions of the projects, the lack of consensus was attributed primarily to no more than three factors (Cost-Benefit Ratio, Technical Merit, and Air Force Need). Also, the individual managers of the projects were unable to accurately specify their personal models although they were consistent in their decision making behavior. The suggested employment of the Delphi technique should be more effective in attaining consensus among the management levels and divisions of the laboratory.

POLICY CAPTURING OF MANAGEMENT
PERSONNEL THROUGH PROJECT-SELECTION
DECISION MAKING IN AN AIR FORCE
RESEARCH AND DEVELOPMENT LABORATORY

THESIS

AFIT/GSM/SM/79S-1

Terry L. Brooks
Captain USAF

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POLICY CAPTURING OF MANAGEMENT PERSONNEL THROUGH PROJECT-SELECTION DECISION MAKING IN AN AIR FORCE RESEARCH AND DEVELOPMENT LABORATORY

THESIS

Presented to the Faculty of the School of Engineering
of the Air Force Institute of Technology
Air University (ATC)
in Partial Fulfillment of the
Requirements for the Degree of
Master of Science

by

Terry L. Brooks, B.S.
Captain USAF

Graduate Systems Management
September 1979

Preface

This research effort would not have been possible without the tremendous support by a large Mid-Western Air Force Research and Development Laboratory. I wish to personally thank Mr. H.M. Davis whose enthusiatic efforts as the laboratory coordinator were unmatched.

I also wish to express my appreciation to three of the Air Force Institute of Technology professors: Capt. Michael J. Stahl, my advisor, for his encouragement and untiring efforts; Lieutenant Colonel Adrian M. Harrell, my reader, for his continued support and statistical background; and Lieutenant Colonel Charles W. McNichols for his ability to produce the right computer program for any problem area.

Finally, I wish to thank my wife, Susan, who typed this thesis and maintained her sanity through it all.

Terry L. Brooks

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Abstract

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POLICY CAPTURING OF MANAGEMENT PERSONNEL
THROUGH PROJECT-SELECTION DECISION MAKING
IN AN AIR FORCE RESEARCH AND DEVELOPMENT LABORATORY

I. Introduction

One of the essential inputs for a modern manager, so that he may perform in that role, is information. However, in most cases the wealth of information can easily overwhelm the manager. For example, the complex environment of a Research and Development(R&D) manager involves search of that environment for opportunities, generation of options (projects), sequential evaluation at different levels of the organization, project-selection, and implementation (Schwartz and Vertinsky, 1977:285). The project-selection decision includes generating new alternatives, determining the appropriate time to make a decision, collecting the data, specifying constraints and criteria, and recycling, as well as selection of projects and allocation of resources (Baker, 1974:166). This decision process depends on the organizational framework.

Statement of Research Problem

The management of a particular Air Force R&D Laboratory has indicated that there exist some problem areas in determining the selection of the specific R&D projects. The problem is the variation in the weightings for key factors

(attributes) that are used as inputs for the R&D project-selection process. These variations are encountered within the organization as a whole, management levels, and divisions. The laboratory has to do with two types of R&D projects, 6.2 and 6.3. The 6.2 projects (programs) primarily explore feasibility and practicability of proposed solutions to specific military problems. These programs range from studies and fundamental technical development to sophisticated breadboard hardware. On the other hand, the 6.3 projects are characterized by the fabrication of experimental hardware to demonstrate projected capabilities by testing under environmental or operational conditions (DoD Handbook 7045.7-H, May 1977).

The 6.2 project decisions are determined at all levels of management (Command, Division, Branch, and Group; Figure 1-1), whereas 6.3 projects are determined only within the upper echelons of the management structure (Command, Staff, Division, Deputy Program Element Monitors(DEPEM), and Advanced Development Project Office Managers(ADPO); Figure 1-2). The inconsistencies can be noted on either 6.2 or 6.3 projects.

This research effort investigates the weights for key factors used by members of the various management levels while pursuing decisions concerning the R&D project-selection. In order to accomplish this type of research, the judgement policies of the members of the different management levels regarding these decisions were identified using the research

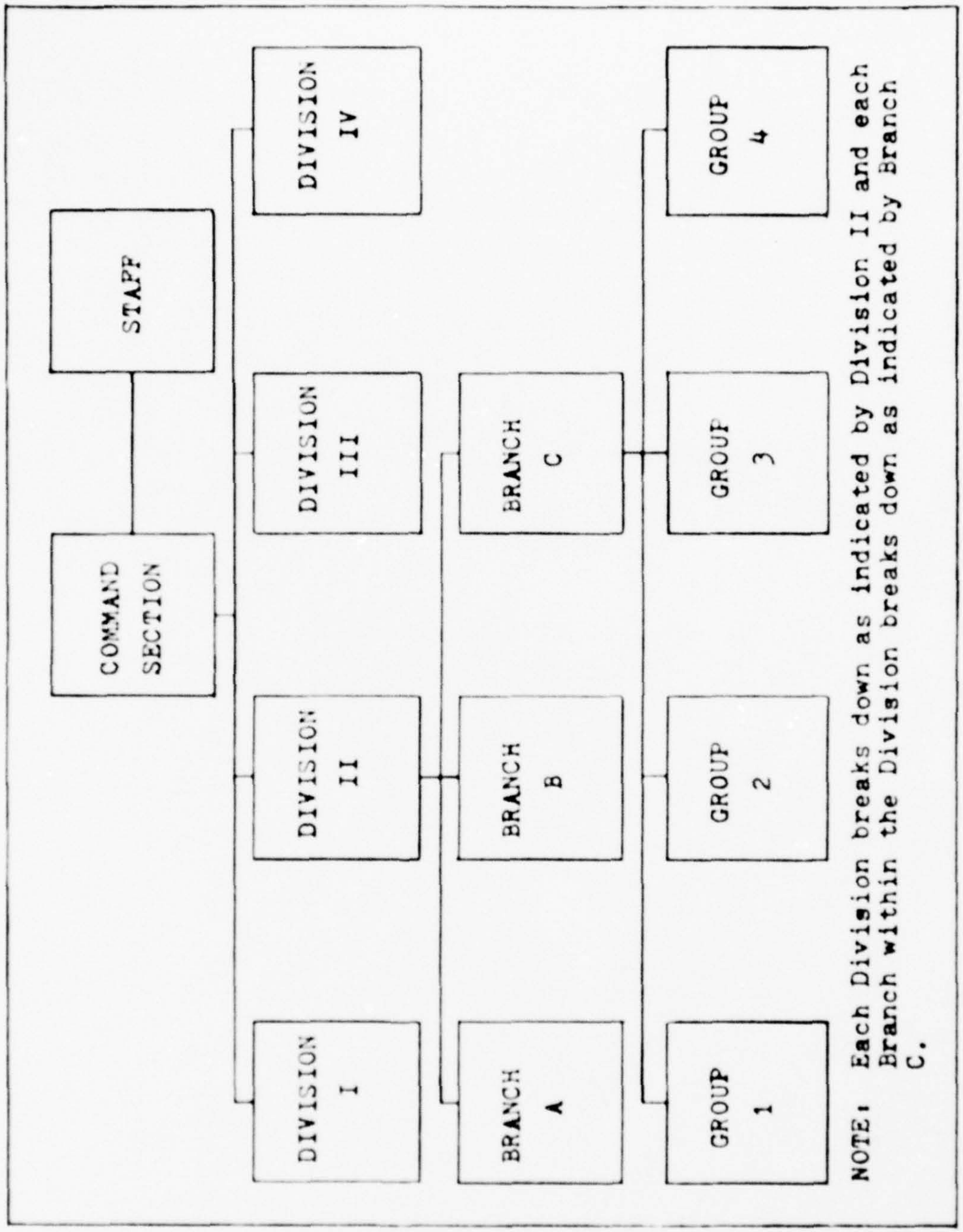

Figure 1-1. General Structure of Management Levels for 6.2 Programs.

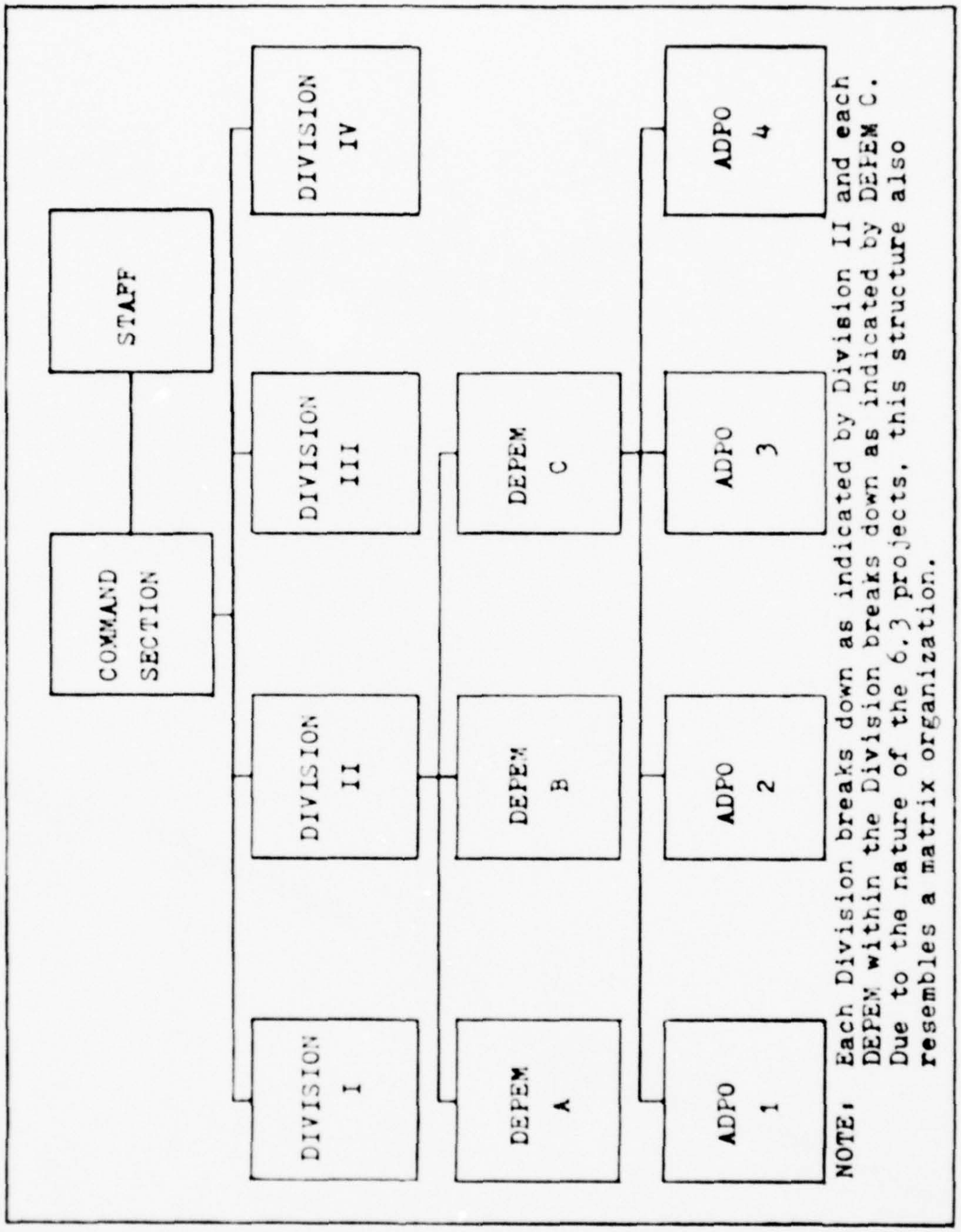

Figure 1-2. General Structure of Management Levels for 6.3 Programs.

approach known as policy capturing (Reference Chapter II).

<u>Objectives of the Research</u>

The fundamental objective of this research effort was to model R&D project-selection decisions at the different levels of management within the organization. The empirical data collected from the laboratory were used to examine the following research hypotheses:

H1: Managers combine the R&D project-selection criteria in essentially a linear fashion while rendering a judgement.

H2: The average individual manager's R^2 ($\bar{R}^2$) is higher than the R^2s of the different levels of management ($\bar{R}^2 > R^2_{CS} > R^2_{S} > R^2_{D} > R^2_{B} > R^2_{G} > R^2_{Tot}$). R^2 is a measure of the consistency with which the attributes are entered into the determination of the overall decision.

CS = Command Section
S = Staff
D = Division
B = Branch
G = Group
Tot = Entire Laboratory

H3: Managers incorporate available information in their R&D project-selection decisions by utilizing the selected R&D factors in the R&D project-selection decision process.

H4: Each manager places the same relative weights upon the criteria used for R&D project-selection decisions. (Judgement policies are homogeneous among all managers.)

H5: Each management level places the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the levels of management.)

H6: Each division places the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the divisions.)

H7: Managers accurately specify the relative weights they place upon the criteria used to render the R&D project-selection decisions.

H8: Managers of both 6.2 and 6.3 projects place the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the 6.2 and 6.3 managers.)

NOTE: H1, H2, H3, H6, and H7 were tested for both 6.2 and 6.3 projects.

Scope and Limitations of the Study

This study was conducted among a selected group of individuals (an Air Force R&D Laboratory). Therefore, it would be very unlikely that generalization could be made about all Air Force R&D Laboratories. As a result, caution should be exercised before applying the findings of this study to other R&D laboratories.

The R&D project-selection decision making exercise included six attributes that were molded into a decision making instrument with 32 simulated projects by Drs. M.J. Stahl and A.M. Harrell (1978). These attributes were determined by personal interviews with the management personnel within the R&D laboratory and it is assumed that these attributes are representative of the information available to the management personnel during the decision making process in the laboratory environments.

Subsequent Chapters

Chapter II of this study discusses goal congruence, consensus, policy capturing, social judgement theory, and the Delphi technique in conjunction with formulating a decision model. Chapter III describes the research methodology, including the instrument used, and the way the data were collected and analyzed. The research results are presented in Chapter IV, and Chapter V summarizes the key findings and indicates the conclusions from the study.

II. Extensive Literature Review

In order to understand the decision making process in an organization through a technique called policy capturing, it is paramount to understand the inner workings of the organizational structure. Srinivasan (1974) refers to this organizational structure as goal-directedness. Goal-directedness encompasses all aspects of purposeful system behavior (i.e., adaptation, learning, and control).

In theory, organizations (systems) are considered to be oriented toward goals and objectives (Porter, Lawler, and Hackman, 1975:78). The goal set-up of this type of system can be viewed in two ways: 1) The system operates towards a definite goal. This goal requires the system to accept a certain normative framework; however, this framework may be rejected if a different goal is sought. 2) The system is involved in an evolutionary process (dynamic organization). The organization is thus viewed as going through a continuous process of goal-setting (problem posing) and goal-seeking (problem solving) behavior (Srinivasan, 1974:105-106).

Importance of Organizational Goals

Basically, goals are defined as desired future states of affairs. The organizational goals serve several important functions. The goals focus attention to the actions that need to be carried out. They tell what "should be" done.

A source of legitimacy is provided by goals in that there exists justification for actions or decisions. Goals in conjunction with other measures serve as a standard for the organizational member to assess his/her ability to perform his/her duties or carry out certain actions. The structure of the organization and organizational goals interact, each affecting the other. Additionally, goals provide clues about the organization. In many cases, they are key parts of an organization and essentially express what the organization is really like (Porter, et al., 1975:78-79).

Expectation affects the perceptions and behavior of an individual and others (Goldstein, 1962). Individuals experience the group atmosphere in individual ways. Therefore, it would be reasonable to assume that goals and expectations will affect an individual's group experience. Consequently, the importance of finding effective ways of identifying goals and expectations of the group, as well as an individual's perceptions of the experience, must be stressed (McCanne, 1977:534).

Classification of Goals

Porter, Lawler, and Hackman (1975) classify goals into three categories: official goals, operative goals, and operational goals. The official goals are the publicly stated goals of an organization. These goals are found in the organizational charter, the official documents, the policy statements of its offices, and the like. Operative goals

provide the basis for organizational policy formulation, operating decisions, development and application of information and control systems, and other management functions. Operative goals are considered to be in force whether or not there exists a conscious organizational goal-setting process, and they may be supportive of, indifferent to, or directly opposed to, the official goals of the organization (Manley, 1972:3). Goals are said to be operational when there are "agreed upon criteria for determining the extent to which particular activities or programs of activity contribute to these goals" (March and Simon, 1958:194).

The literature indicated that goals can be categorized into three additional types. Bozeman and McAlpine (1977) conducted an experiment to determine how certain attitudes and strategies of individuals affect the choices from a set of controlled contexts representing a bureaucratic decision environment. The main concern was the decision pattern in which an individual strives to maximize an individual goal to the detriment of organizational (bureaucratic) or mission goals. The <u>individual goal</u> is related to the power and prestige of the individual; whereas, the <u>bureaucratic goal</u> is related to both the specified objectives of the organization and the individual's perceptions of the organizational goals. Finally, the <u>mission goal</u> is related to the perception of the individual as to the social mission of his/her profession. The findings of the experiment indicated that there was a significant association between professing

a team strategy of pursuing points for mission goals, and in fact, behaving in a manner in which individual goals are maximized.

The very fine line separating the definition of the various classes and types of goals presents additional problems in the area of communication from the management level to the worker level. The interpretation of goals in many cases is inconsistent not only at the different levels of management, but also among the different worker levels. This inconsistency can and does lead to numerous problems within an organization that is supposedly seeking an attainment of a specific set of goals or objectives. Therefore, a greater understanding of this goal-congruent behavior would be a definite aid to "managers."

Goal Congruence

A primary concern of goal congruence is the need for a measurement scheme for the performance of the executives and subordinates which will induce goal-congruent behavior under uncertainty (Itami, 1975:74-75). The ultimate criterion used in selecting a performance measure has been whether the measure induces the action of the subordinates while, at the same time, leading to better overall performance. However, this measure is invalid with the introduction of uncertainty (i.e., environmental factors). Therefore, the congruence of attitudes toward risk may be one of the crucial factors in the discussion of goal congruence, especially

in a decentralized decision making situation under uncertainty. As a result, the problem of goal congruence is complex and involves numerous factors such as organizational structure, uncertainty in environment, incentive schemes, and personal goals of members of the organization.

Another view of goal congruence is that goal congruence plays a key role in organizational and small group processes (Kochan, Cummings, and Huber, 1976:528). As an example, the leadership process will not occur if the parties do not share a common goal. If common goals exist, then compliance can be achieved without the power process. Otherwise, conflict occurs. The theories of conflict have centered on the differences in the goals as the major antecedent to conflict within the organizations (March and Simon, 1958).

The literature on organization behavior is continually growing. A deeper understanding of the role of goals in organization behavior is inevitable for those researchers using decision making processes as their central focus (Kochan, et al., 1976:528-529).

Consensus

Collective decisions are the most common type of decisions that individuals are faced with in social systems. However, this type of decision analysis has two basic faults as pointed out by Coleman (1966). The problems of collective decisions are based on one specific assumption that each individual is a purposive agent with some goals or purposes in

mind. The first problem relates to an individual faced with certain alternatives. The individual will choose the outcome that has the highest utility. The second problem of collective decision concerns a group of individuals (two or more) faced with a number of alternatives. In some instances, an alternative may be preferred by all; therefore, it is chosen. However, in most cases an alternative will not be preferred by all individuals concerned; consequently, the theory breaks down. The basic problem is the absence of consensus for a choice. As a result, there is a failure to predict the outcome.

El-Hakim (1978) conducted a study on decision making by consensus. The most striking feature of the consensus decisions was that each decision critically depended on the achievement of an informal unanimity by the group before any positive decision could be reached. The emphasis on unanimity implied that a minority (a single person) could veto any collective action. The decisions were made when there was no expressed disagreement (consensus). If disagreement persisted, no decision was made. The major disadvantage to the consensus decision process that this group used was the fact that one individual's decisions could help a majority form a certain action. However, this particular group exchanged control among the villagers, in that, if an event did not interest them, then they would not veto the event in exchange for support on an event that was of greater interest to them (El-Hakim, 1978:55-64).

Souder (1975) conducted an "impact procedure" (similar to the Delphi technique) in which four organizations were tested for shared values and organizational consensus. The results indicated that two of the four organizations elicited high consensus. The two organizations which did not achieve global consensus lacked legitimized formal leadership and clear statements of the larger needs of the total organization. Another indicator of consensus that resulted from the study was the degree to which the participants were willing to engage in open conflict. In this case, the more open the conflict, the higher the degree of consensus attained (Souder, 1975:680).

Predictive Consensus Techniques. There are various methods that can be used to predict consensus (Helmer and Rescher, 1960:46-47). The following list is representative of the procedures available for predicting consensus:
1) The simplest method is to select one favored expert and accept his/her sole judgement. 2) Various expert valuations could be pooled into an average or a mean weighted technique to reflect past predictive success. 3) Several experts could be used to act as a single group in which a decision is made after the discrepancies have been eliminated.
4) Again, a group of experts could be used, but in this case, the experts include their best second guess probabilities. The result is that the influence of the most influential group member is diminished. 5) Another consensus measure is the Delphi technique. This technique is a method for

the systematic solicitation and collation of informed judgements on a particular topic (Turoff, 1970:149).

Although these techniques are representative of the ones available to measure consensus, it is important to note that no one method is universally the best technique. However, the Delphi technique is being studied more and more to determine the validity of measurement for this method.

The Delphi Technique

The Delphi procedure is one method of producing forecasts of future events. Delphi was developed by Helmer and Gordon at the Rand Corporation in the early 1960's (Martino, 1968:139). Delphi forecasting is one of the most popular forms of deriving reasoned expectation about the nature and consequences of emerging developments. "The forecast can be represented as a group judgement situation in which a number of individuals from various disciplinary backgrounds, with input relevant to the forecasting topic, judge the probable occurrence of events and provide supporting rationale for their judgements" (Salancik, 1973:243). For any decision, there is a crisis of concepts, ideas, alternatives, diagnoses, foresight, and planning. Delphi is an attempt to deal with all of these (Coates, 1975:193). "This mode of controlled interaction among the respondents represents a deliberate attempt to avoid the disadvantages associated with more conventional use of experts, such as round-table discussions or other milder forms of confrontation with opposing views"

(Dalkey and Helmer, 1963:459).

Delphi is characterized by three features: anonymity, controlled feedback, and statistical response. Anonymity means that the members do not know who else is serving on the committee. The individual is also unaware of any prior knowledge of questions, the origination of these questions, forecasts, or any issues that are being considered. Controlled feedback means that the exchange of ideas and comments are routed through some type of control (director), who screens out the extraneous material and consolidates the remainder before presentation to the committee. These precautions keep the committee members from reviewing irrelevant material. Statistical response means that the committee does not necessarily have to reach a consensus or achieve some majority position, and that all minority views are considered in the final result (Martino, 1972:37). In essence, the Delphi technique enables a large group of individuals to communicate meaningfully and rapidly with each other in generating group forecasts and in making policy decisions (Turoff, 1971:55-57).

Objective or Purpose of Delphi. The Delphi procedure is one method of obtaining an explicit forecast (Martino, 1968:138). In this type of study, the major purpose of the investigation is to describe potential for future events. To do this, the Delphi technique attempts to obtain a consensus of opinions from a group of respondents. This consensus might be in terms of the timing of some future event

in which an effort is made to describe the potential event in such a manner that all respondents interpret the information in the same way (Salancik, Wenger, and Helfer, 1971: 65). Some other objectives of this technique are: 1) to determine or develop a range of possible alternatives, 2) to explore or expose underlying assumption or information leading to differing judgements, 3) to correlate informed judgements on a topic spanning a wide range of disciplines, and 4) to educate the respondent group as to the diverse and interrelated aspects of the topic (Turoff, 1970:149). The objectives or combination of objectives from this list can cause the design of the summary and feedback procedures to vary to some extent.

Network of Delphi. Since the Delphi technique is relatively new, there is very little that can be agreed upon by the numbers of practitioners who have experimented with it. This disagreement is exemplified by the following questions: 1) Is the respondent group completely anonymous among its own members, to the design team, or to the user body? 2) Should Delphi be used in conjunction with a committee ongoing study effort? 3) Must the design teams be knowledgeable in the subject material or do they rely on the respondents to fill out the subject material? 4) Should the iterations (feedback) be cycled to the same respondent groups interacting serially or in parallel with one another? 5) How many iterations are needed? and Why? 6) How do you evaluate a consensus and are the respondents really using the same

definitions of terms and concepts? (Turoff, 1970:150). These are only a few of the key questions that must be considered before the formulation of the Delphi technique.

Although a number of different questions need to be answered before the application of Delphi, there exists a relative amount of procedural harmony among the various practitioners. Basically, the first step in implementing Delphi is the selection of the panel (group of experts) in the subject area in which the study is to be made. The question arises here as to "where does the organization select the experts?" (inside or outside of the organization). This depends on the diversity of the experts available within the organization. After the complex task of selecting the panel, the second step is the initial stage questionnaire. This questionnaire requests each panel member to list, for example, the attributes or cues that he/she considers for selecting a research and development project. This portion is usually deliberately phrased in as vague and unstructured a way as possible to preclude inhibiting the panelists or restricting their thinking. Finally, a number of additional questionnaires (usually no more than three) are sent to the panelists one at a time; each questionnaire contains statistical information about the previous answers to questions plus additional questions (Johnson, 1976:45-55; Martino, 1968:138-144). When the questionnaires are returned, two types of information are extracted from them prior to the design of the next questionnaire: structured responses and

written comments. Usually due to a time constraint, a very simple method is used for the questions (i.e., multiple-choice questions). In many cases, computers are used to aid in the analysis process (Schneider, 1972:487).

The main issues in a Delphi study are the direct impacts on the responses of the panel members. These issues are: 1) the possibility of panel fatigue as the number of topic statements becomes very large, 2) the consistency in panel responses, 3) the change of responses as a characteristic of the size of the Delphi studies, and 4) the early plurality of panel responses on many questions. Plurality refers to a number of respondents who have an immediate consensus on the first set of questions (arbitrarily a 70% figure is used in the literature). The larger the Delphi (number of panel members), the more complex the procedures become (Huckfeldt and Judd, 1974:76).

Uses of Delphi. Schneider (1972) focused on five possible uses for the Delphi method. These were as follows: 1) This method has potential as an educational device. However, in order to use this technique as an educational tool, one must ask if it is cost-effective. 2) It could possibly be used in the definition of both action and research programs. 3) The technique may be of value to a continuous planning concept because it offers a method of obtaining the trends in the values or goals held by different constituents. 4) This method would be useful in obtaining individual participation in policy and goal formulation efforts. 5) Lastly,

the technique could be used to serve political objectives. However, the initiator should use caution in the political arena because the technique could rapidly deteriorate in such situations.

Judd (1972) pointed out that Delphi could be used in conjunction with cost-effectiveness and cost-benefit analysis. However, one obvious use is in the area of education where a consensus of values or evaluations is determined. On the other hand, Delphi has received its widest use in the area of technological forecasting (Turoff, 1970:150).

Advantage of the Delphi Technique. Scheele (1975), Martino (1968), and Turoff (1970) agree that the main advantage of the Delphi technique is the elimination of the principle bottleneck in the committee procedure. Committee activity is completely excluded which greatly reduces the bandwagon effect and the unwillingness to abandon publicly expressed opinions. The direct debate approach of the committee activity is replaced by a carefully designed program of sequential questionnaires, intertwined with information and feedback derived from earlier questionnaires of the program. In essence, the use of the Delphi studies "allows for the opportunity to get opinions from a broader group of people than could be assembled in a single place without great difficulty" (Scheele, 1975:215).

In addition, Helmer and Gordon (1964) state, "No claims are made, or can be made, for the reliability of the Delphi predictions. However, in as much as they reflect explicit,

reasoned, self-aware opinions, expressed in light of the opinions of associate experts, such predictions should lessen the chance of surprise and provide a sounder basis for long-range decision making than do implicit, unarticulated, intuitive judgement." Therefore, without substantial evidence that Delphi is unreliable, it can be concluded that it exhibits a predictive characteristic that is just as powerful as any other technique that is available at the present time. Johnson (1976) also indicated that the group median obtained from the Delphi process is usually more accurate than the median obtained from an individual response.

Results Obtained from the Application of Delphi. Sufficient time has passed since the development of Delphi so that the accuracy of the method can be sufficiently evaluated. One study examined six different forecasts of computers and information processing technology in which Delphi techniques were used. Martino (1972) compiled the results. The findings indicated that of the 89 events forecasted to occur between 1968 and 1972, 49 had occurred with the indication that there seemed to be a slight tendency for events to occur earlier than forecasted. Another researcher, Judd (1972), concluded that the use of Delphi in the college arena proved that "a wide range of possible goals and objectives, evaluated by quite different publics, can be the objective of a Delphi exercise." Judd also noted that the various illustrations made it apparent that Delphi techniques

are very diversified.

Johnson (1976) noted that Delphi was a very powerful tool for use in market studies. In this particular study, Johnson determined that Delphi excelled in the following three areas: 1) An excellent quantity of information was extracted from many disciplines. 2) There existed strange divergent opinions indicating a movement towards consensus. 3) The panel members who participated in the study were very committed. A total of 90 percent of the panel members stayed with the study from start to finish.

Brockhaus and Mickelsen (1977) inferred that "70 percent of the respondents felt that the quantification of the consensus of expert opinions in Delphi studies has considerably enhanced the acceptability of the findings by the organization for which the study was conducted. The remaining 30 percent of the respondents felt that quantification did enhance the acceptance of the results, but only to a slight degree."

The Delphi method has thus achieved a true consensus without too much of a sacrifice of important opinion, while at the same time, the impracticalities of a group discussion are avoided. The expert is aided by the investigator who reworded the questions to attain a consensus. On the other hand, the experts are forced to help themselves toward a consensus by rethinking through the problem by reviewing the divergent estimates. Consequently, the results have indicated a very successful process.

Criticisms of Delphi. Sackman (1975) points out users should be suspect of the Delphi technique. He feels that the practitioners have questionable motives. In addition, Sackman interprets the name "Delphi" as a catchy term which bears connotation of oracular insight. The biggest promotion of Delphi is the regularity and uniformity that exists during the implementation and use of the technique, but Sackman indicates that in fact these procedures and techniques are of a highly diverse collection.

Turoff (1970), from a more realistic standpoint, reviews four potential dangers of the Delphi technique. The four dangers are: 1) Individuals can misinterpret the intent of the use of the Delphi technique. 2) Occasionally, the designers of the exercise are accused of a biased viewpoint. 3) The designers of the technique must make the decision maker(s) aware that once the process begins there is no way to control or guarantee a specific outcome. 4) There is a possible contention that Delphi is being used as a political tool as opposed to an analysis tool. These dangers are good indicators that the implementation of Delphi must be a careful and cautious process which includes exploring numerous underlying factors. In addition, a ten year study conducted by Johnson (1976) for Corning Glass Works revealed other criticisms. More specifically, event questions in the different questionnaires were misinterpreted and in some cases certain questions contained compound events. Also, other problems were noted due to the complexity in filling out the

questionnaires. Finally, Martino (1972) pointed out that Delphi methods are based on data from the past and this data cannot be used to predict something that represents a complete break with the past.

These cited criticisms are the key to the future existence of the Delphi technique. If these criticisms are overlooked, the present results for the most part will be inadequate and this additional aid to decision makers will go awry.

Research and Development Project-Selection

Aside from the Delphi technique which is a method for measuring consensus and goal congruence, the literature on Research and Development(R&D) abounds with formal procedures and sophisticated models for project evaluation and selection. In many of these articles, the assessment of probabilities is required. However, the subjective character of these probabilities entails two serious problems which may have contributed to the low acceptance of these models: 1) The first problem concerns the reliability and validity of the probability assessments (i.e., their degree of association with the actual project outcomes). 2) The second problem refers to the fact that subjective probabilities by their very nature may vary from person to person and thus lack uniqueness (Rubenstein and Schroder, 1977:137).

In order to gain a more thorough understanding of the R&D process, it is useful to investigate the various

components of the selection process. Schwartz and Vertinsky (1977) have focused upon environmental scanning in the process of R&D project-selection, while Souder (1975) focused his attentions upon the organizational problem of achieving a consensus. Schwartz and Vertinsky (1977) have focused on yet another component of the selection process: the formation of individual preferences among R&D investment opportunities. Special attention was paid to the relationship between the characteristics of the executive, position and function, the attributes of his organization, and the trade-offs he was willing to accept in forming his judgements (decisions). Schwartz and Vertinsky (1977) also formulated a list of 47 indicators or intrinsic attributes which exist prior to any probability assessment and independent of any assessor. After these attributes were rated by executives, the list was shortened to the following: 1) cost of project relative to total R&D budget; 2) payback period; 3) probability of technical and commercial success; 4) market share impact; and 5) expected rate of return.

The cost of the project relative to the total R&D budget of a firm is a measure of resource commitment. The payback period refers to a measure of the time commitment to a project. The probability of technical and commercial success is a measure of risk. The market share is often a subsidiary goal of firms, or from an economic view, it is a reflection of the competitive power of the company and of market security. Lastly, the expected rate of return is a

measure of profitability in certain environments (Schwartz and Vertinsky, 1977:285-286).

The assessment of the probabilities of the attributes for R&D projects may be conceived as being composed of four phases. The first is the perception phase where the intrinsic project attributes are perceived by the assessor(s). The second is the evaluation phase where qualitative judgements begin to emerge, while in the third phase or transformation phase, the qualitative judgements are transformed into numerical values which are the assessor(s) subjective probabilities. Finally, the review phase is where the assessor(s) subjective probabilities are communicated. However, to complicate matters further, interpersonal differences can be found in each of these four phases due to personal, organizational, and situational variables.

The personal variables refer to the ability of the assessor to perceive and evaluate the attributes of a project and transform these into a numerical rating. The organizational variables refer to the impact that the position of the assessor in the company hierarchy and the reward system employed have on the assessment process, while situational variables refer to the involvement of the assessor in the project or the department of top-management interest in the project (Rubenstein and Schroder, 1977:138). As a result, subjective probabilities suffer from inconsistencies in most organizations in which this information is available.

Rubenstein and Schroder (1977) presented a study of

organizational-situational variables that reviewed the impact of the assessors' specific relation towards a project and the impact of the assessors' hierarchical position. The specific relation towards a given project was subdivided into project responsibility and project idea generation. The impact of the organizational-situational variables on the assignment of subjective probabilities for R&D projects can be summarized as follows: 1) Both participation in project-idea generation and prospective project responsibility are likely to result in relatively high probability assessments. 2) There is a tendency for higher ranked assessors to assign lower probabilities than their subordinate due to a tendency to fill the "knowledge gap" with conservatism.

Another problem area concerning assessment of subjective probabilities with a given set of R&D projects results from the dissimilar perceptions of organizational goals among the individuals that make up the organization. Souder (1975) designed an impact study to investigate four groups of individuals with each group consisting of personnel from the same organization. Each group had a combination of a president (in two groups only), division managers, directors, and managers. In essence, each group filled out individual paired comparison instruments for the criteria they used in selecting R&D projects. Then, each group met and discussed the number of criteria used and determined a single set of criteria that should be used. This completed one cycle for the individuals. After a week of normal duty, the second cycle

was completed. Then finally, a third cycle was completed a week later.

In each cycle the same individuals were assigned to the same groups. The results of the impact procedure suggested that this procedure may have general utility in many planning and policy formulation situations in addition to the important problem of R&D investment projects. Many hidden social-interpersonal conflicts and leadership were revealed in the group discussions for each of the four groups. The successfulness of the experiment depended primarily on whether the participants were willing to engage in open conflict, whereas dissatisfaction was related to a clear avoidance of open conflict (Souder, 1975:669-680).

Meadows (1968) conducted an investigation on four R&D laboratories primarily in the areas of technical and commercial success with respect to project-selection. The results indicated that three of the four laboratories made no attempt at all to rank products on the basis of their technical success or commercial performance. Meadows concluded that current laboratory selection procedures typically expend more than 50 percent of the firm's development resources on projects that do not produce commercially successful products. Also, there is a tendency for technically and commercially unsuccessful projects, as a group, to incur greater cost overruns than commercially successful projects which results in unsuccessful projects costing more on the average.

Criticisms of Model Formulations for R&D Project-Selection. Baker and Pound (1964) noted through interviews that although a number of models exist, very few have received testing with respect to feasibility and/or desirability. Also very few of these models have seen even limited formal use. The interviewers criticized models or methods primarily in four different areas. Firstly, model construction remains an ambiguous facet because R&D project-selection lacks structure and definition of objectives. So far, R&D project-selection has failed to be described adequately in a thorough and detailed manner. Secondly, data availability and reliability were criticized by personnel of organizations that maintained historical records of decision analysis and by those personnel of organizations without this information. There seemed to be no application for the information in models. Thirdly, acceptance of the models was criticized due to a lack of detailed exposure to the mathematical and statistical techniques being proposed. There also exists no clear demonstration that using a formal method is highly advantageous. Finally, implementation and use were mentioned. Although the model is accepted, the result is a termination of model use due to the sponsor leaving the organization or due to the organization being somewhat unstable.

Many models inherently are possessed with a number of limitations. Baker and Freeland (1975) point out a few of these. There is an existence of the lack of adequate treatment of risk and uncertainty, of multiple criteria, of

project interrelationships, and an inability to recognize and treat nonmonetary aspects such as establishing and maintaining balance in the R&D program. Based on these limitations, it becomes more apparent why decision managers refuse to implement quantitative models for the R&D project-selection and resource allocations.

Examples of Models/Methods. A list of the models/methods follows which are identified by the name or names of the originators:

1) Mottley-Newton (1959)-This is a decision theory approach. Project proposals are rated with respect to a number of evaluation criteria. An overall score is computed and used to rank the alternatives. Selection criteria are considered with respect to constraints including research budget, risk, and overall program balance (Baker and Pound, 1964:127).

2) Freeman (1960)-This is an operations research approach. For each alternative project, an estimate is made of the probability distribution of net value. Selection is accomplished by maximizing expected discounted net value subject to constraints on the total budget, facilities, and personnel. A linear programming formulation is used (Baker and Pound, 1964:126).

3) Gargiulo, et al. (1961)-This is a decision theory approach. Project proposals are rated with respect to a number of evaluation criteria. An overall score is computed and used to rank the alternatives. Constraints such as research budget, skills available, facilities available, and competitor

efforts in the area are considered (Baker and Pound, 1964: 126).

4) Asher (1962)-This is an operations research approach. For each alternative project, estimates are made of the discounted net value of the project and probability of success. Selection is accomplished by maximizing expected discounted net value subject to constraints on the man hours available and on the raw materials available. The optimal manpower allocation is indicated by the result. A linear programming formulation is used (Baker and Pound, 1964:126).

5) Hess (1962)-This is an operations research approach. For each alternative project, estimates are made of the discounted gross value as of several points in time. Probabilities of success are also estimated. Selection is accomplished by maximizing expected discounted net value subject to a budget constraint for the first period. The optimal allocation to each project is indicated for each period. A dynamic programming formulation is used.

6) Baker-Pound (1964)-This is a decision theory approach. Project proposals are rated with respect to a number of weighted selection objectives. An overall score is computed and used to rank the alternatives. The budget constraint is considered.

7) Cramer-Smith (1964)-This is an economic analysis and operations research approach, an application of portfolio selection and utility theory to the problem of research project-selection. For each alternative project, estimates are

made of net values and probabilities of occurrence. Utility curves are also obtained. Projects may be ranked on the basis of expected value or expected utility. Lack of project independence is also mentioned (Baker and Pound, 1964: 127).

8) Nutt (1965)-This is an operations research approach, a deterministic model which quantifies the value or technical payoff of each research task. The model developed considers the world environment; the Air Force missions future weapons systems configurations; laboratory technical objectives; and the timeliness, complexity, and scope of each research effort. The result consists of recommended funding levels of efficient tasks along with suggested tasks for close scrutiny or possible elimination-a modified linear program.

9) Wells (1966)-This is a decision theory approach to store, track, and properly relate judgements concerning systems; to show the impact of these judgements; to permit real-time iterations of planning problems to facilitate the assessment and selection of system candidates for development. Criteria are: threat, types of war, policy objectives, functions, systems contributions, force structure, technical feasibility, schedule and cost, and budget (Cetron, Martino, and Roepcke, 1967:7).

10) Dean-Hauser (1967)-This is an economic analysis and operations research approach, an application of project-selection under constrained resource conditions. By using mathematical models, computer programs, and available information

concerning costs, uncertainties, and military values, it is possible to obtain optimum solutions. The case study has developed a mathematical model for handling the large number of alternatives through the use of a series of simpler computerized methods. There the results of one stage are used in the succeeding stage. A dynamic programming formulation is used.

11) Belt (1966)-This is a decision theory approach based on quantified subjective judgements on the predicted value of a successful laboratory project outcome, the likelihood of success of the project in terms of its technological achievability, the specific plan of attack and the suitability of the proposed performers of the work, and the predicted cost. This technique stops short of producing a single numerical rating of project value, but gives the decision maker the opportunity to select from a group of alternative projects (Cetron, Martino, and Roepcke, 1967:7).

12) Cetron-Martino-Roepcke (1967)-This is an operations research approach. Factors taken into account are importance of military missions, criticality of technological effort to mission, and level of technology required. Funds are allocated among technical projects on the basis of maximum marginal payoff per dollar, with a budget total.

13) Watters (1967)-This is a zero-one integer programming approach with a budget constraint in each of several future time periods. Interesting features include the use of an objective function incorporating risk; probabilistic

constraint rows; and the development of model equations for the cases of project dependence and independence (Gear, Lockett, and Pearson, 1971:68).

14) Keefer (1978)-This is a multiobjective decision analysis carried out to help management of a major corporation's Research and Engineering Division in planning its allocation among six "missions," or areas of responsibility. The allocation involves tradeoffs between competing objectives. This analysis formally considers the uncertainties and multiple objectives, yet has only modest data requirements due to its use of approximations and its focus on mission rather than on individual projects. This approach uses concepts, techniques, and results from decision analysis, particularly from multivariate utility theory.

15) Aaker-Tyebjee (1978)-The concept of interdependence is incorporated into this R&D project-selection and budget allocation model. The model is termed INTERACT to reflect the fact that it was designed to deal explicitly with project interactions and because its use will encourage the interaction of groups of people within the organization.

This list of models is not an exhaustive one but presents somewhat of a broad picture that researchers are attempting to model. However, the majority of the models listed are not considered useable out of the environment in which they were originally designed. The researcher for this study has chosen a newer technique referred to as policy capturing in which the methodology is simpler and is easily

modified to apply to different environments.

Policy Capturing

Policy capturing is essentially quantifying the process used by a decision maker through which informational attributes (cues) are weighted and combined resulting in a decision. Gooch (1972) defines policy capturing as "... identification and quantification of the attributes that are pertinent to a decision and the subsequent mathematical description of the decision policy for the evaluation of these attributes." Smith (1972) defines policy capturing a little differently by referring to it as "... the building of a model which, given the same information the individual has, will accurately reproduce his judgements based on that information." Both researchers are referring to the "actual combination of the question and the desire to produce a mathematical (or heuristic) model of the judgement making process" (Jones, Mannis, Martin, Summers, and Wagner, 1976: 7).

Policy capturing is not a panacea but should be considered as an aid to decision makers if:

1. Externalizing and understanding the decision process would enhance communications.
2. It is desirable to remove bias.
3. It is desirable to obtain consistency (goal congruence).
4. There are a number of decision makers (consensus).

5. Several factors influence a decision, and if there were weights for each, these weights would provide a basis for ranking or selecting alternatives, or

6. A routine decision making process exists for which automated decision making would be beneficial (Jones, et al., 1976:1, 2).

This research directly involves R&D project-selection in which all of the above list existed. Once policy capturing has been decided on as the aid to use, the following 17 steps are helpful.

1. Identify the problem (project-selection for AF R&D Laboratory).

2. Determine (if) policy capturing would be a useful tool for addressing the problem (review the above six statements).

3. Identify and define the decision(s) to be modeled (6.2 and 6.3 project-selection).

4. Identify the judge(s) whose decision(s) will be modeled (Managers-Command Section, Staff, Division, Branch or DEPEMs, and Group or ADPOs).

5. Identify the organizational structure as it relates to the judge(s) and to the decision(s) being modeled (levels of management within the laboratory).

6. Identify the factors which provide the judge(s) the information needed to make decision(s) (review actual work environment in which decisions are to be made).
7. Form a set of variables (cues) from the factors previously identified (Cost-Benefit Ratio, Technical Merit, Resource Availability, Likelihood of Success, Time Period, and Air Force Need).
8. Select an appropriate response scale and data collection procedure (graphical scale from -5 to +5 including zero for R&D project-selection support in a decision making exercise). Note: See Chapter III and Appendix A for further details.
9. Specify the type of case to be presented (hypothetical R&D projects).
10. Select a statistical design to yield desired information (linear multiple regression).
11. Consider physical aspects of the case presentation (similar to actual environment).
12. Pilot test experimental procedure and refine the experiment (pretest instruments).
13. Present cue data, collect responses and record pertinent non-formal remarks (See Appendix G).
14. Formulate models (See Chapter IV).

15. Cross validate and/or validate the model(s) (See Chapter III).

16. Investigate irregularities, diversities among models and unresolved conflicts for judgement or organizational policy implications (See Chapter V).

17. Utilize model results with appropriate control (use caution in the implementation phase).

(Jones, et al., 1976:36)

As a result of these seventeen steps, the amount of consensus is measured and the determination is made as to whether the organization is operating in a goal congruent environment or not.

Reasons for the Use of Models. The philosophy underlying the studies involved with modeling is that man frequently relies on information that is probabilistic in nature when making decisions concerning the state of his environment. The model represents man's inference about his environment (Beach, 1967:276).

The biggest problem concerning models developed through policy capturing is the difficulty in passing along the path from theory or model to application (Conrath, 1973:873). Dawes (1971) points out the question of how can a model based on an individual's behavior do a better job of what the individual is trying to do than the individual himself? "The answer, by its very nature, is an abstraction of the process it models; hence, if the decision maker's behavior involves

following valid principles but following them poorly, these valid principles will be abstracted by the model-as long as the deviations from these principles are not systematically related to the variables the decision maker is considering." The paramorphic representation, a term introduced by Hoffman (1960) which means the mathematical representation of the judgement process, would not be affected by extraneous variables such as fatigue, headaches, and boredom. Therefore, if these extraneous variables are not related to the relevant variables, then the model will attach the correct weights to the relevant variables.

A second major reason for the use of models is cost-benefit analysis which was presented by Goldberg (1970) and Dawes (1971). In both studies, the researchers proved that the use of judgemental models is inherently less costly than the use of human judges due to the fact that the judges who were used to derive the models were free to perform other activities after the models were formulated. Another reason for the use of models is a method for determining the amount of consensus within an organization such as this particular research.

<u>Decision Making Process</u>. Before policy capturing can be completely comprehended, a brief description of the decision making process is presented. Goldberg (1968) depicted the role of the human decision maker as that of a scientist who is discovering or identifying new cues which will improve predictive accuracy and determining new procedures to combine

factors in increasingly more optimal ways. However, the decision maker often encounters numerous problems. Slovic and Hoffman (1969) and Einhorn (1971) indicated that the general problem is understanding the process by which the decision maker combines information to make evaluative decisions. Hoffman (1960) in the clinical judgement research restricted the clinical evaluation of patients in the following manner: (a) the information available was reduced to a common set of variables, (b) the information was expressed in a number of categorical responses, and (c) each variable satisfied the properties of at least the ordinal scale.

Other problems are also in existence. In many cases, the individuals who are to participate in the decision process to determine a model for a decision situation, refuse to take part which results in situations that are not able to be modeled. Also, the models that are formulated are quite different for each individual indicating very different decision making processes. Finally, the evaluation model that subjects feel they use is often quite different and more complex than what they actually use (Huber, Sahney, and Ford, 1969:488). For example, equally attractive choices or alternatives will lead to a random choice, and when the alternatives are of similar total value and different in qualities, the individual will choose with a probability of near 50 percent (Slovic and Hoffman, 1969:7). Taylor and Wilsted (1976) also state that attempts by decision makers to describe their policy are often inaccurate and overstated in

complexity.

Aside from the individual decision making process, groups are considered in many instances of the decision making process. Holloman and Hendrick (1972) in their study offered evidence that the quality of decisions made by groups was positively related to the amount and quality of interaction among the group members. Basically, the more interaction the better the quality of the final decisions. Although consensus was attained by the group, it was responsible indirectly for the interaction due to the differences of opinion.

Although group decisions appear to be better than those derived by individuals, problems do exist. Examples of the problems in the interacting groups are as follows:

> 1. Members of interacting groups often attempt to influence others in proportion to their self-perceived relative competence.
> 2. Dominant personalities often lead to dyfunctional solutions.
> 3. Interacting groups require time and effort to maintain themselves.
> 4. More resources are required to create an interacting group than a nominal group.
>
> (Huber and Delbecq, 1972:163)

Another step in the process of decision making is the choices which involve certain amounts of risk. Myers and Melcher (1969) indicate in their study of decision making

that there are four factors that underlie the choices of various risk pairs. First, the number of alternative choices must be considered whether there are few or many. Second, the planning horizon is examined in relation to its length (short or long). Third, the past success rate of commitments is reviewed. Finally, the expected cost-revenue consequences (high or low) affect the strategy of the decision maker(s).

In summary, the span of absolute judgement and the span of immediate memory impose certain restrictions or limitations on the amount of information that an individual or group of individuals can comprehend and process. Bruner, Goodnow, and Austin (1956) note:

> "Where the nature of a task imposes a high degree of strain on memory and inference, the strategy used for coping with the task will tend to be less conducive to cognitive strain. To put it in terms of an analogy, if someone has to move a heavy weight, there is ... likelihood that the mover will have recourse to strainreducing techniques for carrying out his task."

Also, individuals experience a definite recoding process with information during the decision making process. The general consensus among researchers is that this process is an orderly set of relationships (Miller, 1956:95-96). Therefore, the decision making process can be simplified to the following statement:

> "The whole trick is to decide what variables to look at and then to know how to add" (Dawes and Corrigan, 1974: 105).

Brunswik Lens Model. The Brunswik lens model is the basic framework for conceptualizing decision making. Brunswik (1956) was the originator of this model of the judgement process (Beach, 1967:276). A number of other researchers have used the Brunswik lens model in their studies (e.g., Beach, 1967; Jones, _et al_., 1976; Hursch, Hammond, and Hursch, 1964; Naylor and Schenck, 1966; Stenson, 1974). The basic idea is that the real world decisions have to be made concerning the criterion without direct knowledge of that criterion. In general, factors (cues) are determined and used to measure the criterion. The judges perceive, weigh, and combine these cues in a manner which is referred to as the decision process. Slovic, Fischhoff, and Lichtenstein (1977) feel that this process can be described by the use of a linear regression equation. (Refer to _Linear Models and Multiple Regression_, p. 45, for further discussion.)

The model below (Figure 2-1) is divided into the environment and the judge's action (judgement or policy). The terms of the model can be described as follows:

X_j = value of the i^{th} cue

Y_j = the actual value assigned to the criterion by the judge

$\hat{Y}_j$ = the prediction about the judge's action

Y_e = criterion in which the judge is interested

$\hat{Y}_e$ = the best predicted value of the criterion that can be achieved from the given cues

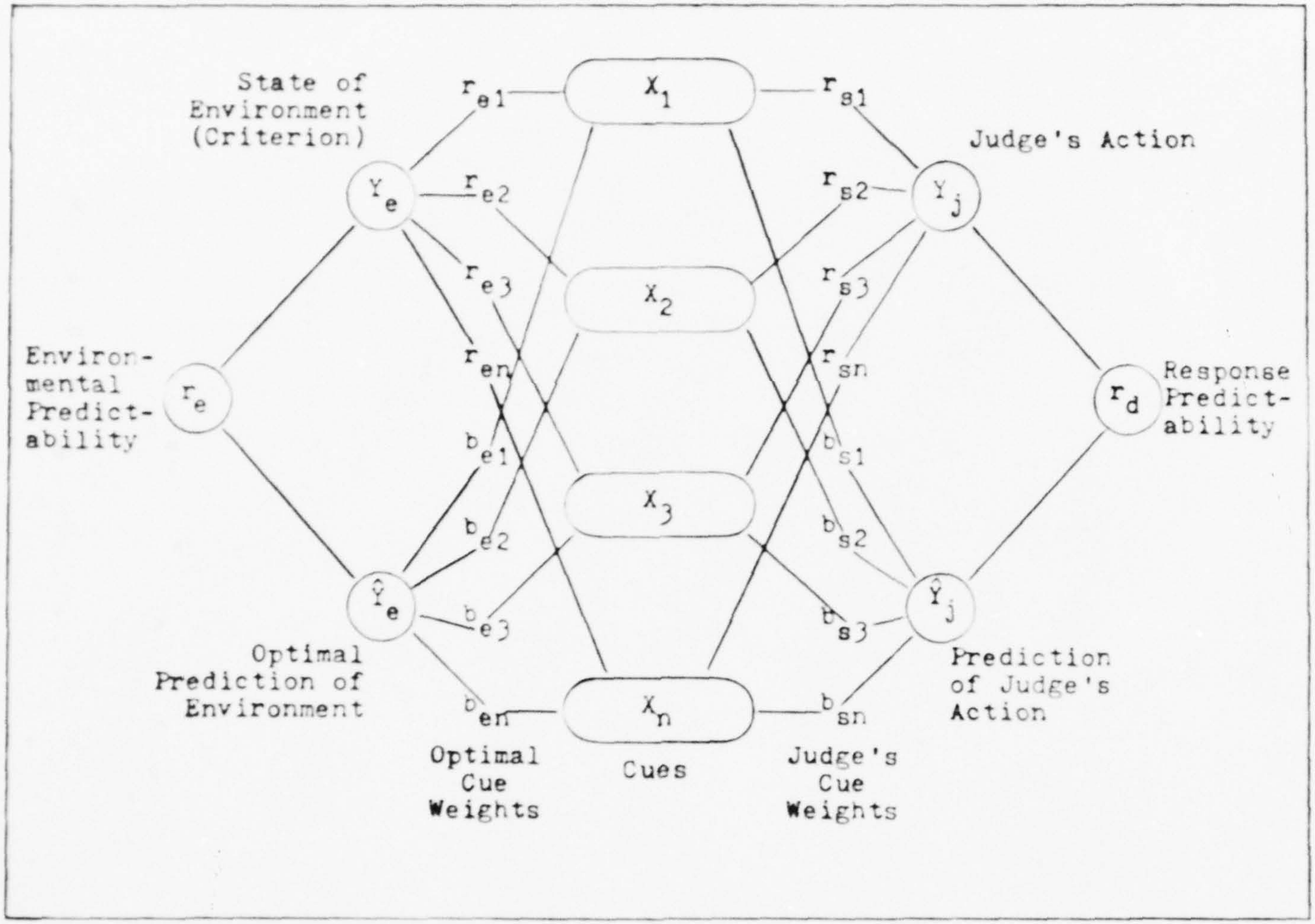

Figure 2-1. Brunswik Lens Model (Beach, 1967; and Jones, et al., 1976)

$r_{s1}, \ldots, r_{sn}$ = cue weights for the judge (utilization weights)

$r_{e1}, \ldots, r_{en}$ = optimal cue weights for determining actual criterion

$b_{s1}, \ldots, b_{sn}$ = predicted cue weights for the judge

$b_{e1}, \ldots, b_{en}$ = optimal cue weights for prediction of judge's action

r_e = correlation (environmental predictability) that measures how well the model (of reality) corresponds to reality

r_d = correlation (response predictability) that measures how well the judge can be predicted by his model

The following multiple regression equations hold for this model:

$$Y_e = r_{e1}x_1 + r_{e2}x_2 + \ldots + r_{en}x_n$$

$$\hat{Y}_e = b_{e1}x_1 + b_{e2}x_2 + \ldots + b_{en}x_n$$

$$Y_j = r_{s1}x_1 + r_{s2}x_2 + \ldots + r_{sn}x_n$$

$$\hat{Y}_j = b_{s1}x_1 + b_{s2}x_2 + \ldots + b_{sn}s_n$$

The task of the Brunswik lens model is essentially to penetrate the realm of uncertainty and make the best intuitive inference about the environment.

Linear Models and Multiple Regression. The first use of linear models dates back to the time of Benjamin Franklin (1787) in which he developed a system that he could use as an aid in decision making. His mathematical approach was referred to as "moral or prudential algebra." In 1923, Vice-President Wallace proposed the use of a linear model on

the corn judge by regressing his ratings of corn quality. Again, thirty-seven years later, Hoffman (1960) proposed that a linear model could represent expert judgements (Dawes and Corrigan, 1974:95, 100). Since that time, a number of authors have concluded that linear models are good paramorphic representations or good at capturing the policy of judges (Beach, 1967; Christal, 1968; Dudycha and Naylor, 1966; Naylor, Dudycha, and Schenck, 1967; Goldberg, 1968; Hammond, Hursch, and Todd, 1964; Naylor and Schenck, 1966; Wherry and Naylor, 1966; and Brehmer, 1969). Slovic and Lichtenstein (1971) and Slovic, Fischhoff, and Lichtenstein (1977) contain extensive bibliographies.

There exist opposing views concerning linear models. Many researchers have conducted studies with the use of linear and non-linear models. Hoffman (1960) determined that the non-linear model multiple R was approximately five percent higher than the multiple R of the linear model. However, considering the factors of chance, this increase with the use of non-linear models was insignificant. Brehmer, Kuylenstierna, and Liljergren (1974) presented results which indicated that the learning associated with a linear function is much faster than non-linear functions. Also, these authors noted that the rules extracted from the subjects' judgements were much higher for the linear hypotheses than the non-linear hypotheses. Goldberg (1971) designed an experiment to investigate five models-Linear, Conjunctive, Disjunctive, Logarithmic, and Exponential. His results

indicated that the linear model provided a better representation of the subjects' judgements than any of the other models.

The question often arises, "Why do linear models work?" Dawes and Corrigan (1974) through their investigations have determined that linear models work because of the following reasons:

1. Predictor variables have conditionally monotone relationships to the criteria. In other words, the variables can be scaled in such a way that higher values on each predict higher values on the criterion, independently of the values of the remaining variables.
2. There is error in the dependent variable.
3. There is error in the independent variables.
4. Deviations from optimal weightings do not make much difference.

Through the successful predictive power of the linear model, a new term, "bootstrapping," appeared in the literature. This term referred to the phenomenon that the linear model of the judge often does a better job than the judge himself.

Another area of conflict in policy capturing is whether to derive the model through the use of linear models with the multiple regression technique or equal weights. Dawes and Corrigan (1974), Cattin (1978), Keren and Newman (1978), and Doran and Drasgow (1978) were all researchers exploring the use of multiple regression and equal weights. Keren and

Newman (1978) summarized the present research in the following manner:

1. Equal weights procedures can only be justified after application and occasionally equal weights will be slightly better or equal to multiple regression. However, the equal weight technique does not have any explanatory power beyond prediction.
2. The formal statistical properties of least squares estimate are neither necessary nor sufficient condition for "good" estimators. There is not a specific criterion to use for what is a good estimator. This decision will be dependent upon the particular situation.
3. Just because multiple regression (with sum of squares estimation) does not always provide the ideal solution, it is not sufficient reason to advocate the use of equal weights.
4. The main advantage of equal weights is its simplicity. However, the price that must be paid for this property must be carefully evaluated.

As a result, multiple regression is still the primary statistical research method used.

Social Judgement Theory. Brunswik (1956) indicated with the lens model that individuals rarely have direct access to the distal state that they must judge. Instead, the

environment provides the cues upon which the judge must base his inferences. Social judgement theorists have stressed the need to consider the nature of the environment outside of the laboratory. The objectives of Social Judgement Theory(SJT) are as follows:

1. SJT is intended to be life relevant.
2. SJT is intended to be descriptive as opposed to law-seeking.
3. Social judgement theorists are interested in creating aids for human judgement particularly for those formulating social policy.

(Hammond, Stewart, Brehmer, and Steinmann, 1975:276)

Social judgement theorists refer to zone of ambiguity which can be described by five parameters: (a) the ecological validity of each cue, (b) the form of the function between each cue and the distal variable, (c) the organizing principle of the task, (d) the probabilism inherent in the task, and (e) the extent to which the cues are intercorrelated (Hammond, Rohrbaugh, Mumpower, and Adelman, 1977:4). Variations in these parameters of the zone of ambiguity make generalization about the real world difficult. Therefore, social judgement theorists attempt to incorporate the variations so that generalization can be made.

Empirical regularities that were observed in the laboratory are also observed in the real world. SJT research has indicated the following conclusions:

1. People do not describe accurately and completely their judgemental policies.
2. People are inconsistent in applying judgemental policies.
3. Only a small number of cues are utilized.
4. Understanding another's policy is very difficult when observing his/her judgements or listening to his/her explanation concerning them.
5. Cognitive aids can reduce conflict and increase learning.
6. Linear, additive organizational principles are often adequate to describe judgement processes.

(Hammond, et al., 1975:304-305)

In summary, the researcher has presented in this chapter a number of empirical studies involving measuring consensus and goal congruence. One of the most successful methods of measuring consensus was the Delphi technique. Specifically, this study was concerned with R&D project-selection and the literature indicated a number of models used in this type of environment. The researcher's experiment deals with a newer technique for determining consensus called policy capturing. The next chapter shows the methods by which this technique was employed to determine if consensus existed in a large Mid-Western Air Force R&D Laboratory.

III. Research Methodology

Identification of the Key Factors

The identification of the predictive factors (cues) was the majority of the effort in developing the instrument. Six factors were determined that were most commonly used by the management personnel in the R&D project-selection decision making environment. Doctors Michael J. Stahl and Adrain M. Harrell conducted interviews with the management personnel of the laboratory (Command Section through Branch Chiefs) and took a consensus of the factors used by these individuals in the decision process. The resulting six factors were as follows:

1) Cost-Benefit Ratio. A comparison of cost required to complete this project with the advantages to be received because of its successful completion is ... *
2) Technical Merit. The extent to which this project provides a new or better technical capability to the Air Force is ... *
3) Resource Availability. The availability of the personnel, equipment, facilities, and other resources needed to complete this project is ... *
4) Likelihood of Success. The likelihood that this

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* NOTE: Specific information about the relationships of this attribute was provided here. The factors were dichotomous (either acceptable or excellent). Refer to the Decision Making Exercise in Appendix A.

project will achieve technical success, given its planned time and resource constraints, is ... *

5) Time Period. The amount of time that is needed to complete this project is ... *

6) Air Force Need. The degree to which it has been established that an actual Air Force need for technical capability provided by this project is ... *

The basic construction of the instrument was concluded with the determination of these six factors.

The Design of the Instrument

The instrument was intentionally designed to be very simple. There were two sections included in the instrument. The first consisted of demographic questions establishing the individual's management level and particular division. The second section, then, contained 32 decisions referring to R&D project-selection. In addition, the second section was used to determine an individual's policy throughout the decision making exercise.

Decision Making Exercise

The decision making exercise consisted of a ½-factorial, orthogonally-designed, randomly arranged sequence of R&D project-selection decisions. The same design was used for the 6.2 and 6.3 programs. Each project-selection decision

* NOTE: Specific information about the relationships of this attribute was provided here. The factors were dichotomous (either acceptable or excellent). Refer to the Decision Making Exercise in Appendix A.

contained information about whether each predictor variable (6 cues mentioned above) was rated acceptable or excellent where acceptable means "barely meets minimally acceptable value or requirement," and excellent means "considerably better than minimally acceptable value or requirement." Since there were six predictors (R&D project criteria) and two states for each criteria (acceptable or excellent), there were $2^6 = 64$ possible combinations to consider. However, to minimize the length of the decision making exercise only a ½-factorial design was used which resulted in 32 different projects. The combination of the 32 predictor variable vectors for the projects was determined by a FORTRAN program designed by Dr. Charles W. McNichols. The program was designed so that the combinations generated would be relevant for examining interactions among the factors up to and including five-way interactions. Appendix F lists the sequence of the 32 cue-value combinations.

The R&D project-selection decision consisted of the individual recommending approval or disapproval of funding for the project. Each of the 32 simulated projects were unique in that a mathematically orthogonal vector was representative of a particular project. Therefore, there was no correlation among the predictors in the regression. Consequently, the uniqueness of such an instrument allowed for the assurance of a simple determination of the importance an individual placed on the 6 R&D project criteria. This simple determination was based on the subject's recommendation for the

project. The final decision of the exercise required each individual to distribute 100 points between the 6 cues. In other words, each individual provided his subjective weights for the cues.

After the instrument was designed, a final step had to be completed. This step was to validate the information obtained with the use of the instrument.

Validation

Nunnally (1978) described three types of validity: 1) predictive validity, 2) content validity, and 3) construct validity. Predictive validity is of importance when an instrument is used to determine some form of behavior that is external to the instrument itself. Content validity "depends primarily on the adequacy with which a specified domain of content is sampled" (Nunnally, 1978:91). Finally, construct validity refers to measurement problems in basic research in the behavioral sciences. Since variables are used to explain other variables, researchers must be sure that each variable measures what it was purported to measure (Nunnally, 1978: 87-94).

Reliability is another key term used in conjunction with validation of an instrument. The ease with which the measurement error places a limit on the amount of validity exhibited, results in reliability being a necessary but not sufficient condition. In addition, internal consistency is a measure of importance. It is the estimate of the

reliability based on the average correlation among the items in the test (Nunnally, 1978:212).

Validity is not an "all or none" concept; rather it is usually an unending process. The result is an instrument which is considered valid only to a matter of degree. The following quote emphasizes the complex process of validation:

> "There is no way to prove the validity of an instrument purely by appeal to authority, deduction from a psychological theory, or any type of mathematical proof" (Nunnally, 1978:87).

In many cases the validation process is simplified by numerous assumptions.

The basic assumption made by previous investigators is that models formulated with policy capturing techniques are similar to those formulated under natural judgemental conditions. Brown (1972) was the first to attempt to validate the experimental conditions model as a replacement for the real life model. Brown's research was instigated by Hoffman's works (1960). The models developed by Hoffman were in question because the judgemental task was different in several ways from the judgement with which radiologists normally use. By changing the real life judgement into a contrived one and sufficient altering of the conditions, the resulting decisions are likely to be unrepresentative of the decision making process of the original judgement. Therefore, Brown's research with the Los Angeles Suicide Prevention Center reflected a very similar atmosphere between the simulated situation and the real world environment. The results

of the experiment indicated that the assumptions made by researchers in past investigations with respect to judgemental modeling are correct. More specifically, the models developed from the contrived settings agreed closely with the models developed from natural settings.

On the other hand, two research efforts, Ebbesen and Koneeni (1975) and Phelps and Shanteau (1978), have concluded that the models developed from natural settings are different from those contrived from experimental conditions. The first study by Ebbesen and Koneeni (1975) involved a construction of a bail setting model for judges based on certain factors. The results of the experiment indicated that there was a difference between the controlled laboratory research and the natural environment. However, one key point was overlooked in this study. That is, the factors used in the simulated experiment were not the same as those in the natural environment. For example, the severity of the crime was eliminated from the contrived conditions but was noted as one of the five key factors in the natural settings.

In the second study by Phelps and Shanteau (1978), a similar error was made. The purpose of their research was to derive a model for judging livestock (specifically, gilts). The results of the experiment again indicated a difference between the natural and contrived models. The error was that the conditions of the natural environment and simulated environment were not very similar. Therefore, both sets of results attained by these research efforts were

invalid because of the drastic differences noted between the two environments.

Therefore, as stated above, an extensive effort was exerted in determining the factors to use in this decision making exercise. Based on the consensus among the management personnel of the laboratory concerning the six cues, it was assumed that the simulated R&D project-selection exercise was similar to the actual R&D project-selection environment. Due to the design of the policy capturing instrument, the reliability or R^2 for each individual, as well as group R^2s, was also calculated.

In summary, two key points concerning validation are as follows:

1. Validation always requires empirical investigation.
2. *An instrument is not* validated, only the use to which it is put.

Collection of the Empirical Data

Due to the difference between 6.2 and 6.3 programs, separate subpopulations of the laboratory received the decision making exercise, however, there was some overlap within the upper echelon of management. The 6.2 program management personnel consisted of the Command Section, Staff, Division Chiefs, Branch Chiefs, and Group Leaders. On the other hand, the 6.3 program management personnel included individuals in the Command Section, Staff, Division, DEPEMs, and ADPOs. There were 120 and 49 R&D project-selection decision making

exercise packages distributed by name to the management personnel respectively in the 6.2 and 6.3 programs. In the package a return envelope was enclosed for the individual's convenience. For the returned exercise to be considered useable, each R&D project-selection decision had to be completed. The return rate was 58% for the 6.2 project managers and 69% for the 6.3 project managers.

Coding of the Data

Upon return of the decision making exercises, the data were then coded onto a standard IBM card for each individual. The format used is shown in Appendix G. In addition, a separate listing was maintained for those individuals requesting feedback. An example of the Letter used to assign the codes and the compiled information sheet are included in Appendix E.

Restructuring of the Data for Regression Analysis

Two problem areas were encountered due to horizontal format used in coding the data. First, the regression algorithm available to the researcher required that the regression variables to read line by line. This regression algorithm was the Statistical Package for Social Sciences(SPSS) by Nie, Hull, Jenkins, Steinbrenner, and Bent (1978). The second problem area was that the predictor variables were not associated with the specific decisions of the individuals. Therefore, another FORTRAN program, designed by Dr. Charles W. McNichols, had to be used to eliminate these problem

areas. This program computed each of the individual's R^2s, Beta Weights, and Relative Weights as well as providing for the option of storing the information on tape. After the information was stored, the overall and group regression models were formulated. (See Appendix C for the FORTRAN program.)

Preliminary Checks on the Data

Two F-tests, one for the simple model and one for the interactive model, were constructed and solved for R^2. The respective R^2s found were the minimum values for which an R^2 was considered statistically significant. If any individual in the simple model calculations or interactive model calculations had an R^2 of less than the calculated model R^2s, then the individual's model was considered unuseable for data analyses. In essence, this test was used to measure the internal consistency of the instrument.

After the minimum acceptable values of the simple and interactive model R^2s were calculated, another test was conducted in order to determine whether or not the interactive model was significantly greater than the simple model for that particular individual. Equation B-3 in Appendix B was used to calculate the $\Delta_{R_I^2 - R_S^2}$. Appendix B also includes the basic structure of the two models and the other equations used for the above calculations.

Data Analysis Procedures

The Aeronautical Systems Division CDC 6600 CYBRE 70

Computer was used for all the data analysis including the preliminary checks discussed above. The specific types of analysis used for this study were regression, frequencies, F-test, and t-test.

The regression analysis was based on the sum of squares technique. Each group analyzed had the same forced fit regression model, so that the factors were common to the different groups. This in turn simplified the comparison process. The output of the regression analysis was as follows:

$$b = (X'X)^{-1} X'Y \tag{3-1}$$

where

b is a column vector of standardized regression coefficients (beta weights).

X is the standardized matrix of all the values of the orthogonal cues in the decision making exercise.

Y is the standardized column vector of the individual decision responses.

(McNichols, 1978:4-27)

After the beta weights were calculated, the relative weights were computed for the overall and group models by the use of the following equation.

$$RW_i = \frac{(b_i)^2}{R^2} \quad \text{(for orthogonal predictor variables)} \tag{3-2}$$

where

RW_i is the relative weight for a particular factor.

b_i is the beta weight for a particular factor.

R^2 is the measure of consistency.

(Hoffman, 1960:120-121)

NOTE: The regression weights were all relative weights.

The comparisons and hypotheses tests were conducted with reference to the specific relative weights of the factors in each of the individual and group regression runs (Ward, 1962; and Jones, et al., 1976).

The Chow's F-test was applied to determine if the model formulated for one group was statistically different from those of another group. The general structure of the test equation was as follows:

$$F_o = \frac{SS_E{}^{*} - SS_{Ej}/((p-1)(k+1))}{SS_{Ej}/(n-p(k+1))} \qquad (3\text{-}3)$$

$$\sim F_{(p-1)(k+1),\ n-p(k+1)}$$

where

$SS_E{}^{*}$ is obtained from a regression accomplished with all of the data combined.

SS_{Ej} is the error sum of squares from the regression analysis accomplished with the j^{th} subset of the data.

n is the number of decisions.

k is the number of factors.

p is the number of subpopulations.

(McNichols, 1978:4-56)

Figure 3-1 indicates the various regression runs accomplished. The <u>null hypothesis</u> for the test was that there was no

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	0	0	0	0	0	0	0	0	0	0	0
2	0	X	X	X	X	X	0	0	0	0	0	0
3	0	0	X	X	X	X	0	0	0	0	0	0
4	0	0	0	X	X	X	0	0	0	0	0	0
5	0	0	0	0	X	X	0	0	0	0	0	0
6	0	0	0	0	0	X	0	0	0	0	0	0
7	0	0	0	0	0	0	X	0	0	0	0	0
8	0	0	0	0	0	0	0	X	X	X	X	X
9	0	0	0	0	0	0	0	0	X	X	X	X
10	0	0	0	0	0	0	0	0	0	X	X	X
11	0	0	0	0	0	0	0	0	0	0	X	X
12	0	0	0	0	0	0	0	0	0	0	0	X

Regression Group	6.2 Program	6.3 Program
1	Entire Laboratory	Entire Laboratory
2	Command Section	Command Section
3	Staff	Staff
4	Division	Division
5	Branch	DEPEM
6	Group	ADPO
7	Total Division Population	Total Division Population
8	Division FX	Division FX
9	Division FG	Division FG
10	Division FE	Division FE
11	Division FB	Division FB
12	---	Division FI

Figure 3-1. Regression Runs. The tabular entries indicate a regression run for the group identified by the row/column interactions. The interaction of the same group indicates a regression for that group only.

significant difference between the models formulated for the different groups. The rejection of the null hypothesis, for purposes of this study, indicated that the groups were statistically different in the decision making process used to select the R&D projects. All calculations were based on the .05 level of significance. In addition, frequency runs were generated to produce various statistical information. Six paired sample t-tests were used to determine if the individual subjective weights differed from the regression weights for any of the six cues. A two sample t-test was used to determine which of the specific factors introduced differences among the groups, and also, to determine if the model formulated for the 6.2 program differed statistically from the model formulated for the 6.3 program.

IV. Results

The analysis of the data is provided in this chapter. Each of the eight hypotheses mentioned in Chapter I (pg. 5) were explicitly examined with respect to the 6.2 and 6.3 programs when applicable.

Internal Consistency

Internal consistency(R^2) was used as a reliability measure of this policy capturing technique. McNichols' FORTRAN program (Appendix C) was used to obtain an R^2 for each individual. This program was used to derive the R^2s for the individuals in the 6.2 program, simple and interactive models, as well as the 6.3 program individuals, simple and interactive models. The results are listed in Appendix D. Table I lists the minimum R^2 values that were calculated for the simple and interactive models.

TABLE I

Minimum Values of R^2 (Calculated for the Simple and Interactive Models)

Program	Simple Model R_S^2	Interactive Model R_I^2
6.2 and 6.3*	.374	.853

* The values of R_S^2 and R_I^2 were identical for each program because the same decision making exercise was used for both programs. Equations B-1 and B-2 were used to calculate the respective R^2s (Appendix B).

All of the individuals in the 6.2 and 6.3 programs had significant R^2 values for the simple model. However, approximately 7.2% of the individuals in the 6.2 program and 3.2% of the individuals in the 6.3 program had interactive models that could not be considered statistically different from zero at the .05 significance level. Table II indicates the average R^2s of the individuals in the 6.2 and 6.3 programs for the simple and interactive models.

TABLE II

Average Individual R^2 Values

Program	Simple Model R_S^2	Interactive Model R_I^2
6.2	.826	.930
6.3	.844	.941

In addition, approximately 63% of the simple model R^2s for the 6.2 program and 65% of the simple model R^2s for the 6.3 program were greater than .80. On the other hand, 96% of the 6.2 program and 100% of the 6.3 program R^2s for the interactive model were greater than .80. These very high R^2s indicate that the information provided by the cues was used consistently by the individuals in the policy capturing exercise. In summary, review Figures 4-1 and 4-2.

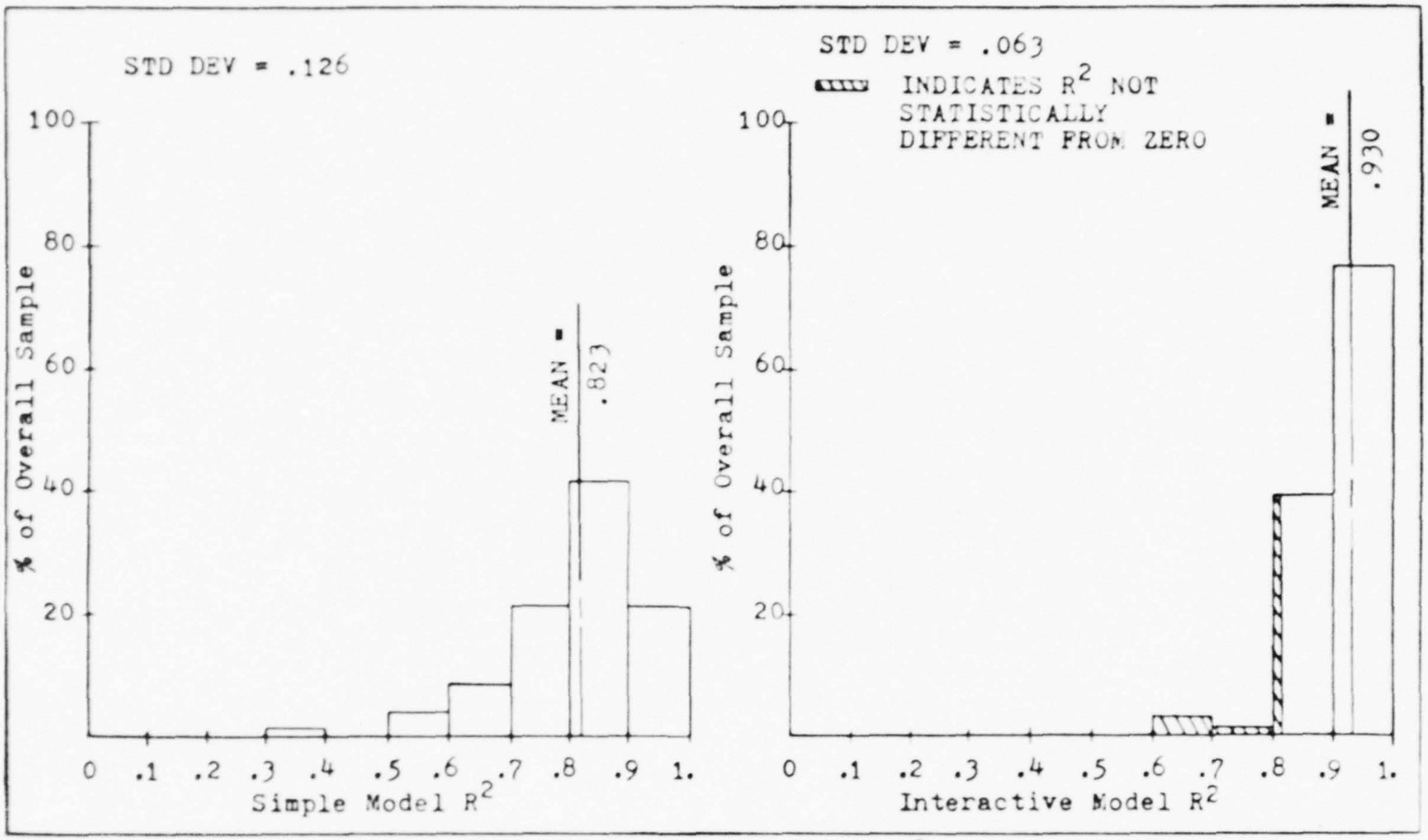

Figure 4-1. Distribution of Individual R^2s (6.2 Program)

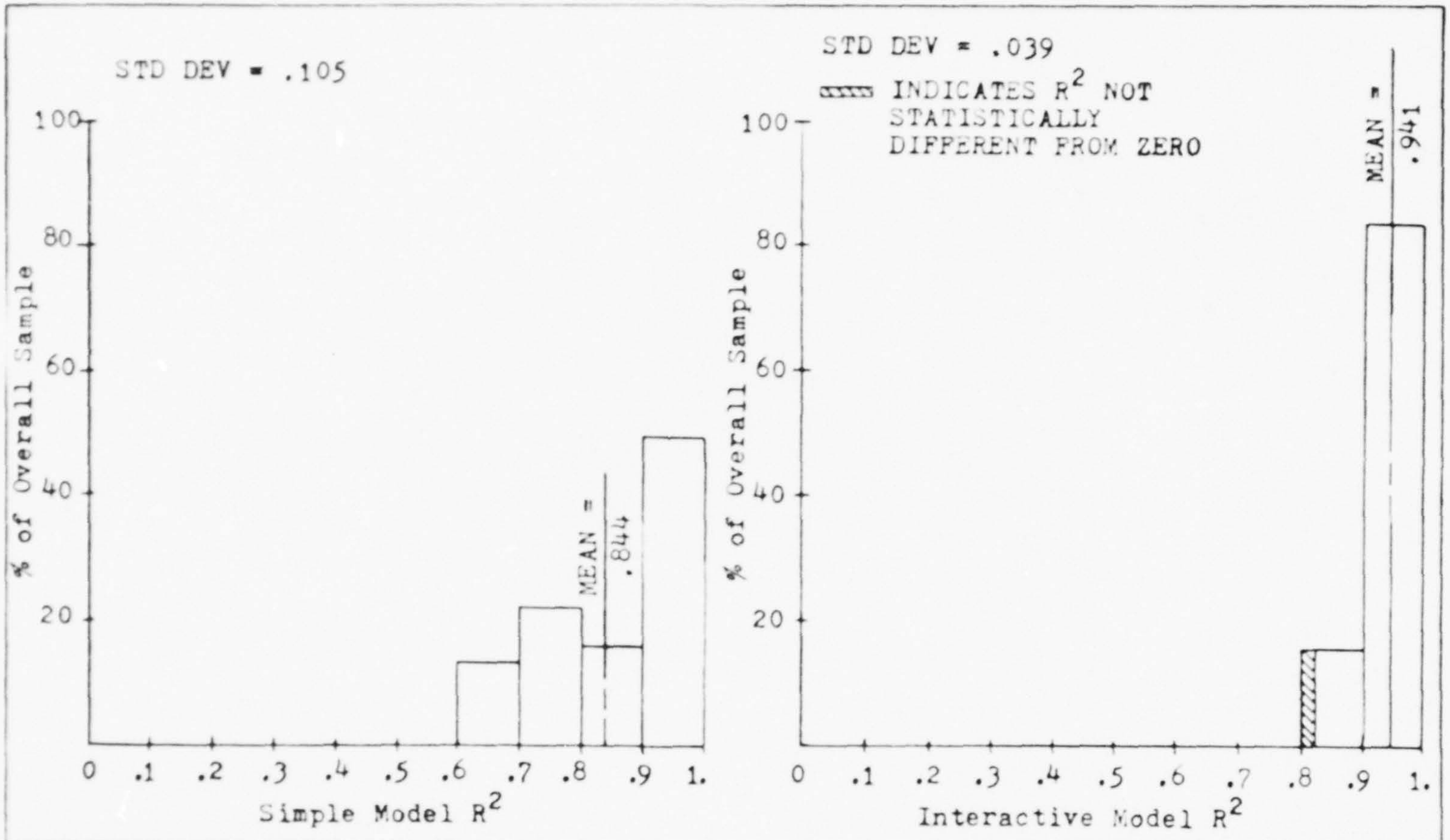

Figure 4-2. Distribution of Individual R^2s (6.3 Program)

Hypothesis #1

> H1: Managers combine the R&D project-selection criteria in essentially a linear fashion while rendering a judgement.

Equation B-3 in Appendix B was used to determine if the simple or the interactive model was significant for each individual. Approximately 8.7% of the individuals in the 6.2 program and 6.5% of the individuals in the 6.3 program had an interactive model that accounted for significantly more variance than the simple model. Therefore, the simple model was used for the remaining data analysis. (Refer to Appendix D for the compiled listing of the results for this calculation.)

Hypothesis #2

> H2: The average individual manager's R^2 ($\bar{R}^2$) is higher than the R^2s of the different levels of management
> ($\bar{R}^2 > R^2_{CS} > R^2_S > R^2_D > R^2_B > R^2_G > R^2_{Tot}$).
>
> CS = Command Section
> S = Staff
> D = Division
> B = Branch
> G = Group
> Tot = Entire Laboratory

This hypothesis was applicable to the 6.2 program individuals. Table III indicates the compiled results. The results although different than those hypothesized were not surprising due to the number of the staff section personnel who indicated on the instrument that they were assigned to the section because of an established job rotation program. Therefore, the low R^2 was indicative of the circumstances.

TABLE III

R^2 Values						
$\bar{R}^2$	CS	S	D	B	G	Tot
.826	.794	.534	.558	.567	.468	.510

In summary, the R^2 values were as high as compared to other research efforts with similar policy capturing exercises.

<u>Hypothesis #3</u>

> H3: Managers incorporate available information in their R&D project-selection decisions by utilizing the selected R&D factors in the R&D project-selection decision process.

The six factors listed in Chapter II (pgs. 51-52) were tested to see if each was used by managers of the 6.2 and 6.3 programs in making their decisions. The results for the 6.2 and 6.3 programs are listed in Table IV.

The high values of t in Table IV were very positive indicators that all six factors were used by the managers in both the 6.2 and 6.3 project-selection decisions. Therefore, all six factors were used in the data analysis.

<u>Hypothesis #4</u>

> H4: Each manager places the same relative weight upon the criteria used for R&D project-selection decisions. (Judgement policies are homogeneous among all managers.)

The Chow's F-test was used to determine if the judgement

TABLE IV

T-Test of Factor Utilization by Managers of the 6.2 and 6.3 Projects

6.2 Project Managers

Factor	Mean Regression Relative Weight	Variance	t
Cost-Benefit Ratio	.089	.010	73.929
Technical Merit	.286	.046	51.646
Resource Availability	.065	.008	67.491
Likelihood of Success	.056	.003	155.057
Time Period	.028	.001	232.585
Air Force Need	.475	.054	73.068

H_o: The regression relative weights for each of the six factors are not statistically different than zero.

Reject H_o if $t = t_{\alpha/2}$ at the .05 level of significance.

$t_{n-1,\alpha/2} = t_{68,.025} = 1.96$

6.3 Project Managers

Factor	Mean Regression Relative Weight	Variance	t
Cost-Benefit Ratio	.123	.011	62.258
Technical Merit	.245	.040	34.103
Resource Availability	.065	.005	72.381

TABLE IV (cont.)

T-Test of Factor Utilization by Managers of the 6.2 and 6.3 Projects

6.3 Project Managers

Factor	Mean Regression Relative Weight	Variance	t
Likelihood of Success	.061	.006	56.606
Time Period	.049	.003	90.940
Air Force Need	.457	.039	65.243

H_o: The regression relative weights for each of the six factors are not statistically different than zero.

Reject H_o if $t = t_{\alpha/2}$ at the .05 level of significance.

$t_{n-1,\alpha/2} = t_{30,.025} = 1.96$

policies were homogeneous among all managers. The test was based on the sum of squares error associated with each individual model and the sum of squares error which resulted from the entire laboratory regression model. The results indicated that at least one manager's model in the 6.2 and 6.3 projects differed from the remainder of the managers in the respective programs. The largest difference was noted with respect to the manager's relative weight of Technical Merit and Air Force Need. Therefore, the models formulated by the managers were not homogeneous in either the 6.2 or

6.3 projects.

Hypothesis #5

> H5: Each management level places the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the levels of management.)

The resulting regression models for the management levels are listed in Table V for the 6.2 projects and Table VI for the 6.3 projects. The Chow's F-test was used to determine if homogeneity existed among the management levels of the respective projects.

The models formulated for the 6.2 project management levels were essentially the same. On the other hand, the models formulated for the 6.3 project management levels were determined to be statistically different.

A mean difference t-test was used to determine where the differences among the management levels for the 6.3 projects occurred. Approximately 86% of the Regression Weight for the model formulated was accounted for by three factors (Cost-Benefit Ratio, Technical Merit, and Air Force Need). Therefore, these factors were reviewed in more detail. The results are listed in Table VII.

The results in Table VII indicated that the Staff and ADPO management levels were the same while the other management level comparisons were different with respect to Cost-Benefit Ratio. Technical Merit caused the most differences among all management levels. Air Force Need, on the other hand, resulted in 50% of the management level comparison

TABLE V

Management Level Models (6.2 Projects)

Regression Group	Cost-Benefit Ratio	Technical Merit	Resource Availability	Likelihood of Success	Time Period	Air Force Need
Entire Laboratory	.069*	.305	.045	.043	.017	.522
Command Section	.097	.319	.001	.059	.030	.494
Staff	.104	.289	.081	.047	.042	.439
Division	.052	.326	.041	.020	.011	.551
Branch	.043	.293	.043	.058	.015	.547
Group	.081	.310	.041	.037	.015	.517

* Regression Relative Weights

TABLE VI

Management Level Models (6.3 Projects)

Regression Group	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
Entire Laboratory	.114*	.237	.047	.042	.041	.519
Command Section	.060	.380	.004	.010	.005	.541
Staff	.099	.039	.142	.088	.063	.569
Division	.076	.340	.042	.024	.014	.505
DEPEM	.146	.132	.045	.069	.119	.489
ADPO	.133	.276	.040	.038	.037	.477

* Regression Relative Weights

TABLE VII

Comparisons of the Management Level Models With Respect to the Factors (6.3 Projects)

Management Levels Being Compared	Factors: Cost-Benefit Ratio	Technical Merit	Air Force Need
Com Sec/Staff	DIFF	DIFF	SAME
Com Sec/Division	DIFF	SAME	DIFF
Com Sec/DEPEM	DIFF	DIFF	DIFF
Com Sec/ADPO	DIFF	DIFF	DIFF
Staff/Division	DIFF	DIFF	SAME
Staff/DEPEM	DIFF	DIFF	DIFF
Staff/ADPO	SAME	DIFF	SAME
Division/DEPEM	DIFF	DIFF	SAME
Division/ADPO	DIFF	DIFF	SAME
DEPEM/ADPO	DIFF	DIFF	DIFF

SAME indicates that the models were not statistically different with respect to that particular factor.

DIFF indicates that the models were statistically different with respect to that particular factor at the .05 level of significance.

Com Sec = Command Section

being considered statistically different. (See Appendix I for the t-test results.)

Hypothesis #6

> H6: Each division places the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the divisions.)

The resulting regression models for the different divisions are listed in Table VIII for the 6.2 projects and Table IX for the 6.3 projects. Again, the Chow's F-test was used to determine if homogeneity existed among the divisions of the respective projects.

For both the 6.2 and 6.3 projects, the F-test indicated that the models formulated for the divisions were different. Again, a mean difference t-test was used to determine the specific division differences. Approximately 84% of the 6.2 project models was accounted for with two factors (Technical Merit and Air Force Need). The results for these factors are listed in Table X. On the other hand, approximately 88% of the 6.3 project models was accounted for with three factors (Cost-Benefit Ratio, Technical Merit, and Air Force Need). Table XI lists the results. The other factors not considered in this discussion accounted for less than 12-16% of the overall model.

The results of Table X indicated that the divisions were completely different with respect to Technical Merit and Air Force Need. No combination of divisions was the same for either factor. The results of Table XI indicated

TABLE VIII

Division Models (6.2 Projects)

Regression Group	Cost-Benefit Ratio	Technical Merit	Resource Availability	Likelihood of Success	Time Period	Air Force Need
Entire Division Population	.064*	.306	.042	.042	.015	.532
PX Division	.055	.441	.047	.030	.018	.409
PG Division	.084	.325	.053	.070	.017	.451
PE Division	.072	.117	.022	.016	.008	.766
PB Division	.038	.236	.038	.061	.010	.618

* Regression Relative Weights

TABLE IX

Division Models (6.3 Projects)

Regression Group	Cost-Benefit Ratio	Technical Merit	Resource Availability	Likelihood of Success	Time Period	Air Force Need
Entire Division Population	.120*	.261	.042	.022	.042	.495
FX Division	.151	.488	.073	.032	.017	.239
FG Division	.090	.332	.033	.023	.047	.474
FE Division	.231	.113	.058	.098	.039	.461
FB Division	.070	.239	.029	.021	.046	.594
FI Division	.102	.212	.020	.102	.062	.503

* Regression Relative Weights

TABLE X

Comparisons of the Division Models
With Respect to the Factors (6.2 Projects)

Divisions Being Compared	Factors	
	Technical Merit	Air Force Need
FX/FG	DIFF	DIFF
FX/FE	DIFF	DIFF
FX/FB	DIFF	DIFF
FG/FE	DIFF	DIFF
FG/FB	DIFF	DIFF
FE/FB	DIFF	DIFF

DIFF indicates that the models were statistically different with respect to that particular factor at the .05 level of significance.

TABLE XI

Comparisons of the Division Level Models
With Respect to the Factors (6.3 Projects)

Divisions Being Compared	Factors		
	Cost-Benefit Ratio	Technical Merit	Air Force Need
FX/FG	DIFF	DIFF	DIFF
FX/FE	DIFF	DIFF	DIFF
FX/FB	DIFF	DIFF	DIFF
FG/FE	DIFF	DIFF	SAME
FG/FB	SAME	DIFF	DIFF
FE/FB	DIFF	DIFF	DIFF

SAME indicates that the models were not statistically different with respect to that particular factor.

DIFF indicates that the models were statistically different with respect to that particular factor at the .05 level of significance.

NOTE: Division FI was eliminated from the calculations because only one individual completed the instrument.

that Divisions FG and FB were statistically the same with respect to Cost-Benefit Ratio. For Air Force Need, Divisions FG and FE were the same. All division combinations for Technical Merit were considered statistically different at the .05 significance level. Division FI was eliminated from these calculations because only one individual completed the instrument. (See Appendix I for the t-test results for both projects.)

Hypothesis #7

> H7: Managers accurately specify the relative weights they place upon the criteria used to render the R&D project-selection decisions.

The individual subjective weights and regression weights were compared by using a paired sample t-test. Table XII indicates the results of the 6.2 project and Table XIII the results of the 6.3 project.

The 6.2 project managers' subjective weights were statistically different from the regression weights for each of the factors. The regression models formulated implied that the managers actually use a different model than they perceive.

As noted with the 6.2 project managers, the 6.3 project managers' subjective weights were statistically different from the regression weights. The 6.3 project managers also use models for the selection of their projects that are different than they perceive. (See Appendix H for the calculation of the difference between the subjective and regression weights.)

TABLE XII

Comparison of Individual Subjective and Regression Relative Weights (6.2 Project)

Factor	t
Cost-Benefit Ratio	6.896
Technical Merit	-2.858
Resource Availability	7.075
Likelihood of Success	11.285
Time Period	5.447
Air Force Need	-8.384

H_o: $\mu_S - \mu_R = 0$ where μ_S = Subjective Weight and μ_R = Regression Relative Weight

Reject H_o if $t > t_{\alpha/2}$ at the .05 level of significance.

$t_{n-1,\alpha/2} = t_{63,.025} = 1.96$

Hypothesis #8

H8: Managers of the 6.2 and 6.3 projects place the same relative weight upon the criteria used for R&D project-selection decisions. (Homogeneity exists among the 6.2 and 6.3 managers.)

A difference between means t-test was used to determine the existence of homogeneity between the managers of 6.2 and 6.3 projects. Table XIV shows the tabulated results of this test.

The results in Table XIV indicate that Time Period was

TABLE XIII

Comparison of Individual Subjective and Regression Relative Weights (6.3 Project)

Factor	t
Cost-Benefit Ratio	3.283
Technical Merit	-2.802
Resource Availability	4.825
Likelihood of Success	5.419
Time Period	4.383
Air Force Need	-6.196

H_o: $\mu_S - \mu_R = 0$ where μ_S = Subjective Weight and μ_R = Regression Relative Weight

Reject H_o if $t > t_{\alpha/2}$ at the .05 level of significance.

$t_{n-1,\alpha/2} = t_{28,.025} = 2.048$

the only factor in which the 6.2 and 6.3 project models statistically differed. However, this conclusion could be misleading because this factor only accounts for a weight of 2.8% in the 6.2 project model and 4.9% in the 6.3 project model. Since this factor also has such a small variance in each case, the probability of concluding a significant difference was very high. Therefore, the difference in Time Period between the 6.2 and 6.3 projects would not be considered substantial. As a result the 6.2 and 6.3 project

Availability			
Likelihood of Success	.056	.003	155.057
Time Period	.028	.001	232.585
Air Force Need	.475	.054	73.068

H_o: The regression relative weights for each of the six factors are not statistically different than zero.

Reject H_o if $t = t_{\alpha/2}$ at the .05 level of significance.

$t_{n-1,\alpha/2} = t_{68,.025} = 1.96$

6.3 Project Managers

Factor	Mean Regression Relative Weight	Variance	t
Cost-Benefit Ratio	.123	.011	62.258
Technical Merit	.245	.040	34.103
Resource Availability	.065	.005	72.381

TABLE XIV

Comparisons Between the 6.2 and 6.3 Project Managers' Models

Factor	6.2 $\overline{X}$	6.2 Variance	6.3 $\overline{X}$	6.3 Variance	t
Cost-Benefit Ratio	.089	.010	.123	.011	-1.549
Technical Merit	.286	.046	.245	.040	0.902
Resource Avail-ability	.065	.008	.065	.005	0.000
Likeli-hood of Success	.056	.003	.061	.006	0.244
Time Period	.028	.001	.049	.003	2.419
Air Force Need	.475	.054	.457	.039	0.375

H_o: $\mu_{6.2} - \mu_{6.3} = 0$ where $\mu_{6.2}$ = mean regression relative weight of 6.2 project

AD-A076 977 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOO--ETC F/G 5/1
POLICY CAPTURING OF MANAGEMENT PERSONNEL THROUGH PROJECT-SELECT--ETC(U)
SEP 79 T L BROOKS
UNCLASSIFIED AFIT/GSM/SM/79S-1 NL

2 OF 3
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TABLE XV

Results of Hypotheses Tests

Project	H1	H2	H3	H4	H5	H6	H7	H8
6.2	Fail to Reject	Reject	Reject	Reject	Fail to Reject	Reject	Reject	Fail to Reject
6.3	Fail to Reject	N/A	Reject	Reject	Reject	Reject	Reject	Fail to Reject

NOTE: See Chapter I (pg 5) for the hypotheses.

V. Summary and Conclusions

Summary

The scope of this study was to investigate the possibility of using the policy capturing technique to model individual members of a large Mid-Western Air Force R&D Laboratory and determine if consensus existed among the levels of management and the divisions within the laboratory. In so doing, eight specific hypotheses were investigated: first, to apply the policy capturing technique and determine if the models were linear; second, to see if internal consistency (R^2) has any set pattern among the different management levels; third, to determine if each manager uses all available information in rendering a decision; fourth, to determine if all managers place the same weight upon the factors; fifth, to determine if each management level places the same weight upon the factors; sixth, to determine if each division places the same weight upon the factors; seventh, to measure the accuracy of an individual manager's subjective weight (distribution of 100 points over the six cues) as opposed to the regression weight (calculated relative weight for the six cues as a result of the decisions); and eighth, to determine if the managers of the 6.2 project formulate the same models as those managers of the 6.3 project.

Methodology. Of utmost importance was the identification process of the factors to be used in the instrument.

Through interviews by Drs. M.J. Stahl and Adrian M. Harrell with the laboratory managers, six factors were determined as the most important for the R&D project-selection decision making process. These factors were: 1) Cost-Benefit Ratio; 2) Technical Merit; 3) Resource Availability; 4) Likelihood of Success; 5) Time Period; and, 6) Air Force Need. A ½-factorial, orthogonally designed instrument was used with these factors representing the informational cues in the decision making exercise.

A total of 32 different R&D projects were rated with regard to approval or disapproval of the project for funding. Through the rating process of the project, the <u>weights</u> that each individual associated with the six factors were captured. *Weight refers to the importance an individual places* on that particular cue.

<u>Results</u>. The high internal consistency (R^2) values were a positive indication of the successful use of the policy capturing technique in formulating the models for the individual managers. Approximately 63% of the simple model R^2s for the 6.2 project and 65% of the simple model R^2s for the 6.3 project were greater than .80. None of the individual simple models were eliminated from the study for either the 6.2 or 6.3 projects. The interactive model added very little to the analysis.

The R^2 values for the 6.2 project management levels did not have the set pattern as suspected; however, the R^2 values for the groups were as high as those of similar research

efforts.

It was determined that all six factors that made up the decision making exercise were used by the individuals of the 6.2 and 6.3 projects. The t-values were indicative of the high significance associated with each factor. However, each individual manager did not weight the factors the same in either the 6.2 or 6.3 projects.

In the group comparisons, it was found that the 6.2 project management levels weighted all of the factors statistically the same, whereas the 6.3 project management levels weighted the factors statistically different. The key interest factors were Cost-Benefit Ratio, Technical Merit, and Air Force Need. Differences were noted among the management levels in relation to Cost-Benefit Ratio, Technical Merit, and Air Force Need. The other factors were not considered due to the small percent of the model accounted for by them.

The 6.2 project division level models were determined to be statistically different. The largest differences were noted with respect to Technical Merit and Air Force Need. The 6.3 project division models were also statistically different with respect to Cost-Benefit Ratio, Technical Merit, and Air Force Need as the major contributors. Again, the factors eliminated from the above discussion accounted for very little percent of the model.

The comparison of the individual subjective weights and regression weights resulted in significant differences among

the individual managers of both the 6.2 and 6.3 projects. This indicated that the managers as a whole were unable to correctly specify the models they used in R&D project-selection.

Finally, the average individual manager models of both the 6.2 and 6.3 projects were compared. The results indicated that the models were statistically the same.

Conclusions

The results of this study were supportive of policy capturing as a technique capable of modeling individual managers' responses in an R&D project-selection decision making exercise. All of the informational cues were used by the managers and were distinguishable across the management levels and divisions of the 6.2 and 6.3 projects.

The two most important conclusions were that there was not a consensus in the decision making process among the managers of the management levels of the 6.3 project, or the managers in the divisions of the 6.2 and 6.3 projects. Also, the managers of both projects did not use a decision making process exactly the same as that which they perceived.

Recommendations for Further Research. To attain more of a consensus within the laboratory, if laboratory management deems that advisable, a follow on research effort would be suggested. This effort would introduce the technique known as Delphi discussed extensively in Chapter II. Briefly, a desired decision making model should be made available

to the individual managers. An instrument similar to this one should be circulated to them. Then, the individual models should be formulated and the data analyzed. If this process is completed at least twice, a change should result in that the more recently formulated models should then resemble the publicized models.

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APPENDIX A

The Instrument

The cover letters, instructions, and demographic questions for 6.2 and 6.3 projects are included in this appendix followed by the R&D project-selection decision making exercise. The actual decision making section was used for the 6.2 and 6.3 projects.

DEPARTMENT OF THE AIR FORCE
AIR FORCE FLIGHT DYNAMICS LABORATORY
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

Office of the Commander

30 Mar 79

SUBJECT: R&D Project-Selection Decision Making Exercise

TO: AFFDL Management Personnel

1. R&D project decision making is a complex function. Many methods have been tried to provide a systematic approach to programming and budgeting. Recently, Capt Stahl from AFIT described a new decision modeling process called policy capturing which is based upon information obtained from the decision makers themselves. I have asked Capt Stahl and one of his students, Capt Brooks, to devise such a model for AFFDL. You can provide the information they need by completing the attached "instrument." But first, a brief explanation. Making decisions to accept or to turn down a proposed R&D program involves a combination of factors and judgements based upon expectations which cannot be verified at the time. The uncertainty surrounding these decisions is not unique to R&D. For example, supervisors must make decisions about promotions and hiring, and loan officials in banks must recommend acceptance or denial of loan applications. Policy capturing was devised and applied with success in determining the relative importance of the key factors used for promotions and making loans by certain organizations. The possibility for using policy capturing as a tool to better understand R&D program decision making is being explored with this exercise.

2. The measurements will be based on an AFIT-developed decision making exercise (instrument) that takes approximately 15 minutes to complete. Using data already obtained from laboratory managers, the exercise was designed specifically for management personnel whose position requires R&D program selection decision making. The exercise is composed of two parts. The first part of the exercise requires you to identify your level of management so that decision models may be formulated for these levels. The second part involves 32 management decisions. Each decision should be answered with your best opinion.

3. Your participation is strictly voluntary. If you put your name on the exercise, you will be provided the decision model formulated from your responses. A specific coding system will be used to identify the decision models and the thesis student and his advisor will be the only ones who know the code.

4. When you have completed the exercise, place it in the addressed envelope provided and drop it into base mail. A high response rate is needed to build a representative decision model. Thank you for your response.

KEITH I. COLLIER
Deputy Director

1 Atch
Questionnaire

A PROJECT-SELECTION DECISION MAKING EXERCISE
FOR MANAGEMENT PERSONNEL IN THE
AIR FORCE FLIGHT DYNAMICS LABORATORY

THIS IS NOT A QUESTIONNAIRE. It is a project-selection decision making exercise to investigate how managers make certain 6.2 project-selection decisions. The data collected will support a research effort requested by the AFFDL and a master's thesis at the Air Force Institute of Technology but you will not be identified in the final report. Your cooperation is, therefore, sincerely requested. Your input to this research will be kept strictly confidential.

The exercise is divided into two sections. Section I involves two questions referring to your organizational level and Section II involves project-selection decisions with respect to several attributes. There are no "correct" or "incorrect" answers so please respond as candidly as possible. The information provided by you and other respondents will be combined to statistically test hypotheses about how information is used by management personnel in the AFFDL to make certain project-selection decisions. The instrument appears to be lengthy, however, we are only asking you to make 32 decisions.

ALL EXAMPLE PROJECTS ARE 6.2 PROJECTS

If you would like to receive information about your overall response as compared with those of your contemporaries, please print your name and address in the space provided at the end of the exercise. A summary comparison will be mailed to you in confidence after completion of the study (September 1979).

Please return your completed exercise to AFIT/ENS (Capt. Brooks) via base distribution. A return envelope is enclosed for your convenience. Thank you.

I. ORGANIZATIONAL LEVEL

Please indicate your organizational level by checking the appropriate space provided:

_____ Command Section(CC, CD, CA)

_____ Staff

_____ Division Office

_____ Branch

_____ Group

Please check your two letter divisional symool:

_____ FX

_____ FC

_____ FE

_____ FB

DEPARTMENT OF THE AIR FORCE
AIR FORCE FLIGHT DYNAMICS LABORATORY
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

Office of the Commander

16 MAY 1979

SUBJECT: 6.3 Project Selection Policy

TO: AFFDL Management Personnel

1. Recently, some of the management personnel within AFFDL participated in a research effort sponsored by Capt Stahl and one of his thesis students, Capt Brooks, from AFIT. This study has involved the use of a new decision making process called "policy capturing." With the completion of phase I of the study we determined that AFFDL managers probably use a simple decision making model for the project-selection of 6.2 programs. The results so far have indicated that there is no difference in the models among the management levels (Command Section, Staff, Division, Branch, and Group); however, there was a significant difference in the models among the specific divisions (FX, FG, FE, and FB). The second and final phase of this research involves formulating models for 6.3 projects. You can provide the information needed by completing the attached exercise or instrument.

2. The decision making exercise is very similar to the form used for 6.2 projects. The exercise is composed of two parts. The first part of the exercise requires you to identify your level of management so that decision models may be formulated for these levels. The second part involves 32 management decisions. Each decision should be answered with your best opinion.

3. Your participation is strictly voluntary. If you put your name on the exercise, you will be provided the decision model formulated from your responses. Your model identification will remain completely anonymous to other individuals in the AFFDL.

4. When you have completed the exercise, place it in the addressed envelope provided and drop it into base mail. I am especially interested in Phase II due to the significant results provided thus far by Phase I. Thank you for your response.

KEITH I. COLLIER
Deputy Director

1 Atch
Decision Making Exercise

A PROJECT-SELECTION DECISION MAKING EXERCISE

FOR MANAGEMENT PERSONNEL IN THE

AIR FORCE FLIGHT DYNAMICS LABORATORY

THIS IS NOT A QUESTIONNAIRE. It is a project-selection decision making exercise to investigate how managers make certain 6.3 project-selection decisions. The data collected will support a research effort requested by the AFFDL and a master's thesis at the Air Force Institute of Technology, but you will not be identified in the final report. Your cooperation is, therefore, sincerely requested. Your input to this research will be kept strictly confidential.

The exercise is divided into two sections. Section I involves two questions referring to your organizational level and Section II involves project-selection decisions with respect to several attributes. There are no "correct" or "incorrect" answers so please respond as candidly as possible. The information provided by you and other respondents will be combined to statistically test hypotheses about how information is used by management personnel in the AFFDL to make certain project-selection decisions. The instrument appears to be lengthy, however, we are only asking you to make 32 decisions.

ALL EXAMPLE PROJECTS ARE 6.3 PROJECTS

If you would like to receive information about your overall response as compared with those of your contemporaries, please print your name and address in the space provided at the end of the exercise. A summary comparison will be mailed to you in confidence after completion of the study (September 1979).

Please return your completed exercise to AFIT/ENS (Capt. Brooks) via base distribution. A return envelope is enclosed for your convenience. Thank you.

I. ORGANIZATIONAL LEVEL

Please indicate your organizational level by checking the appropriate space provided:

_____ Command Section(CC, CD, CA)

_____ Staff

_____ Division Office

_____ DEFEM

_____ ADPO

Please check your two letter divisional symbol, if applicable:

_____ FX

_____ FC

_____ FE

_____ FB

PRIVACY STATEMENT

In accordance with paragraph 30, AFR 12-35, the following information is provided as required by the Privacy Act of 1974:

a. Authority

(1) 4 U.S.C. 301, Departmental Regulations; and/or

(2) 10 U.S.C. 80-12, Secretary of the Air Force, Powers and Duties, Delegation by.

b. Principal purposes. The survey is being conducted to collect information to be used in research aimed at illuminating and providing inputs to the solution of problems of interest to the Air Force and/or DOD.

c. Routing Uses. The survey data will be converted to information for use in research of management related problems. Results of the research based on the data provided, will be included in written Master's thesis and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether in written form or orally presented, will be unlimited.

d. Participation in this survey is entirely voluntary.

e. No adverse action of any kind may be taken against an individual who elects to participate in any or all of this survey.

II. PROJECT-SELECTION DECISION MAKING EXERCISE INSTRUCTIONS

This section consists of a project-selection decision making exercise. During the exercise, you should assume that you are responsible for recommending or disapproving projects. The only real differences in these projects are the extent to which six key attributes are involved with each of the projects. Assume the projects do not differ on other attributes.

These six attributes are described as <u>ADEQUATE</u> or <u>EXCELLENT</u>. For this exercise ADEQUATE means "BARELY MEETS MINIMALLY ACCEPTABLE VALUE OR REQUIREMENT." EXCELLENT means "CONSIDERABLY BETTER THAN MINIMALLY ACCEPTABLE VALUE OR REQUIREMENT." A sample project is shown below.

PROJECT #0

--<u>Cost-Benefit Ratio</u>. A comparison of the costs required to complete this project with the advantages to be received because of its successful completion is	(Specific information about the relationship of these attributes to minimally acceptable value or requirement will be presented here.)
--<u>Technical Merit</u>. The extent to which this project provides a new or better technical capability to the Air Force is	
--<u>Resource Availability</u>. The availability of the personnel, equipment, facilities and other resources needed to complete this project is	
--<u>Likelihood of Success</u>. The likelihood that this project will achieve technical success, given its planned time and resource constraints, is	
--<u>Time Period</u>. The amount of time that is needed to complete this project is	
--<u>Air Force Need</u>. The degree to which it has been established that an actual Air Force need for the technical capability provided by this project is	

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Strongly Recommend Disapproval										Strongly Recommend Approval

You should circle the number that best indicates your recommendation for this particular project. Make each decision one at a time and independently of the others. Do not change a decision once you have made it. Work at a brisk pace, but don't hurry your decisions. Complete EVERY case, as each case is DIFFERENT.

PROJECT #1

COST-BENEFIT RATIO	ACCEPTABLE
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval ... Strongly Recommend Approval

PROJECT #2

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	EXCELLENT
LIKELIHOOD OF SUCCESS	ACCEPTABLE
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval ... Strongly Recommend Approval

PROJECT #3

COST-BENEFIT RATIO	ACCEPTABLE
TECHNICAL MERIT	EXCELLENT
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	ACCEPTABLE
TIME PERIOD	EXCELLENT
AIR FORCE NEED	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval ... Strongly Recommend Approval

PROJECT #4

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	EXCELLENT
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval ... Strongly Recommend Approval

PROJECT #5

COST-BENEFIT RATIO	ACCEPTABLE
TECHNICAL MERIT	EXCELLENT
RESOURCE AVAILABILITY	EXCELLENT
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	EXCELLENT
AIR FORCE NEED	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval ... Strongly Recommend Approval

PROJECT #6

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	EXCELLENT
RESOURCE AVAILABILITY	EXCELLENT
LIKELIHOOD OF SUCCESS	ACCEPTABLE
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval ... Strongly Recommend Approval

PROJECT #7

COST-BENEFIT RATIO .... EXCELLENT
TECHNICAL MERIT .... EXCELLENT
RESOURCE AVAILABILITY .... EXCELLENT
LIKELIHOOD OF SUCCESS .... EXCELLENT
TIME PERIOD .... EXCELLENT
AIR FORCE NEED .... ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #8

COST-BENEFIT RATIO .... ACCEPTABLE
TECHNICAL MERIT .... EXCELLENT
RESOURCE AVAILABILITY .... EXCELLENT
LIKELIHOOD OF SUCCESS .... ACCEPTABLE
TIME PERIOD .... EXCELLENT
AIR FORCE NEED .... ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #9

COST-BENEFIT RATIO .... ACCEPTABLE
TECHNICAL MERIT .... EXCELLENT
RESOURCE AVAILABILITY .... ACCEPTABLE
LIKELIHOOD OF SUCCESS .... ACCEPTABLE
TIME PERIOD .... ACCEPTABLE
AIR FORCE NEED .... ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #10

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	EXCELLENT
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #11

COST-BENEFIT RATIO	ACCEPTABLE
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	EXCELLENT
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #12

COST-BENEFIT RATIO	ACCEPTABLE
TECHNICAL MERIT	EXCELLENT
RESOURCE AVAILABILITY	EXCELLENT
LIKELIHOOD OF SUCCESS	ACCEPTABLE
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #13

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	EXCELLENT
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #14

COST-BENEFIT RATIO	ACCEPTABLE
TECHNICAL MERIT	EXCELLENT
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	EXCELLENT
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #15

COST-BENEFIT RATIO	ACCEPTABLE
TECHNICAL MERIT	EXCELLENT
RESOURCE AVAILABILITY	EXCELLENT
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #16

COST-BENEFIT RATIO	....	EXCELLENT
TECHNICAL MERIT	....	ACCEPTABLE
RESOURCE AVAILABILITY	....	EXCELLENT
LIKELIHOOD OF SUCCESS	....	EXCELLENT
TIME PERIOD	....	EXCELLENT
AIR FORCE NEED	....	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #17

COST-BENEFIT RATIO	....	EXCELLENT
TECHNICAL MERIT	....	EXCELLENT
RESOURCE AVAILABILITY	....	EXCELLENT
LIKELIHOOD OF SUCCESS	....	ACCEPTABLE
TIME PERIOD	....	EXCELLENT
AIR FORCE NEED	....	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #18

COST-BENEFIT RATIO	....	ACCEPTABLE
TECHNICAL MERIT	....	ACCEPTABLE
RESOURCE AVAILABILITY	....	ACCEPTABLE
LIKELIHOOD OF SUCCESS	....	EXCELLENT
TIME PERIOD	....	EXCELLENT
AIR FORCE NEED	....	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #19

COST-BENEFIT RATIO	ACCEPTABLE
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	EXCELLENT
LIKELIHOOD OF SUCCESS	ACCEPTABLE
TIME PERIOD	EXCELLENT
AIR FORCE NEED	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Strongly Recommend Disapproval										Strongly Recommend Approval

PROJECT #20

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	EXCELLENT
LIKELIHOOD OF SUCCESS	ACCEPTABLE
TIME PERIOD	EXCELLENT
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Strongly Recommend Disapproval										Strongly Recommend Approval

PROJECT #21

COST-BENEFIT RATIO	ACCEPTABLE
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	ACCEPTABLE
TIME PERIOD	EXCELLENT
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Strongly Recommend Disapproval										Strongly Recommend Approval

PROJECT #22

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	EXCELLENT
RESOURCE AVAILABILITY	EXCELLENT
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval | Strongly Recommend Approval

PROJECT #23

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	EXCELLENT
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	EXCELLENT
AIR FORCE NEED	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval | Strongly Recommend Approval

PROJECT #24

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	ACCEPTABLE
TIME PERIOD	EXCELLENT
AIR FORCE NEED	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval | Strongly Recommend Approval

PROJECT #25

COST-BENEFIT RATIO	ACCEPTABLE
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	EXCELLENT
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	EXCELLENT
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Strongly Recommend Disapproval										Strongly Recommend Approval

PROJECT #26

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Strongly Recommend Disapproval										Strongly Recommend Approval

PROJECT #27

COST-BENEFIT RATIO	ACCEPTABLE
TECHNICAL MERIT	EXCELLENT
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	EXCELLENT
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Strongly Recommend Disapproval										Strongly Recommend Approval

PROJECT #28

COST-BENEFIT RATIO .... EXCELLENT
TECHNICAL MERIT .... EXCELLENT
RESOURCE AVAILABILITY .... ACCEPTABLE
LIKELIHOOD OF SUCCESS .... ACCEPTABLE
TIME PERIOD .... ACCEPTABLE
AIR FORCE NEED .... EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #29

COST-BENEFIT RATIO .... ACCEPTABLE
TECHNICAL MERIT .... ACCEPTABLE
RESOURCE AVAILABILITY .... EXCELLENT
LIKELIHOOD OF SUCCESS .... ACCEPTABLE
TIME PERIOD .... ACCEPTABLE
AIR FORCE NEED .... ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #30

COST-BENEFIT RATIO .... ACCEPTABLE
TECHNICAL MERIT .... ACCEPTABLE
RESOURCE AVAILABILITY .... ACCEPTABLE
LIKELIHOOD OF SUCCESS .... ACCEPTABLE
TIME PERIOD .... ACCEPTABLE
AIR FORCE NEED .... EXCELLENT

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Strongly Recommend Disapproval — Strongly Recommend Approval

PROJECT #31

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	ACCEPTABLE
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	ACCEPTABLE
TIME PERIOD	ACCEPTABLE
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Strongly Recommend Disapproval										Strongly Recommend Approval

PROJECT #32

COST-BENEFIT RATIO	EXCELLENT
TECHNICAL MERIT	EXCELLENT
RESOURCE AVAILABILITY	ACCEPTABLE
LIKELIHOOD OF SUCCESS	ACCEPTABLE
TIME PERIOD	EXCELLENT
AIR FORCE NEED	ACCEPTABLE

Indicate below your recommendation regarding approval or disapproval of this project for funding.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Strongly Recommend Disapproval										Strongly Recommend Approval

A FINAL DECISION

Please indicate the relative importance you believe you placed upon the six attributes during the exercise by distributing 100 points among these criteria. The most important attribute, as you perceive it, will receive the most points, and so on.

ATTRIBUTES	ASSIGNED POINTS
COST-BENEFIT RATIO	__________
TECHNICAL MERIT	__________
RESOURCE AVAILABILITY	__________
LIKELIHOOD OF SUCCESS	__________
TIME PERIOD	__________
AIR FORCE NEED	__________
Total Points:	100

Again, thank you for your participation. Remember, if you desire a summary comparison mailed to you, just print your name and address here:

____

____

APPENDIX B

Procedures of the Experimental Design

This appendix includes the equations used for measuring internal consistency and determining whether to use the simple or the interactive model for the data analysis (also includes the structure of the simple and interactive model).

A. These equations were used for the F-test to determine the significance of R^2:

1. Simple Model, R^2

$$F_o = \frac{(n-k-1)R^2}{k(1-R^2)} \qquad \text{(B-1)}$$

$$\sim F_{k,n-k-1}$$

2. Interactive Model, R^2

$$F_o = \frac{(n-k-1)R^2}{k(1-R^2)} \qquad \text{(B-2)}$$

$$\sim F_{k,n-k-1}$$

where in both equations

n = number of decisions (32)

k = number of predictor variables (6 for the simple model; 21 for the interactive model)

(Jones, et al., 1976:133-134)

NOTE: In each of the above equations, R^2 is the unknown.

3. Interactive versus Simple Model

$$F_o = \frac{(R_I^2 - R_S^2)(n-k_I-1)}{(k_I-k_S)(1-R_I^2)} \qquad \text{(B-3)}$$

$$\sim F_{k_I-k_S,\,n-k_I-1}$$

where

n = number of decisions (32)

k_I = number of predictor variables in the interactive model (21)

k_S = number of predictor variables in the simple model (6)

R_I^2 = the R^2 of the individual's interactive model

$R_I^2 - R_S^2$ = the maximum difference between R_I^2 and R_S^2 for which the simple model remains significant

NOTE: R_I^2 is different for each individual.

B. This equation was used for the t-test to determine if a difference existed between the two formulated models (6.2 versus 6.3):

$$T = \frac{(\overline{Y}_1 - \overline{Y}_2) - (\mu_1 - \mu_2)}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \qquad \text{(B-4)}$$

where

$\overline{Y}_1$ = the sample mean relative weight for a particular factor in the 6.2 programs

$\overline{Y}_2$ = the sample mean relative weight for a particular factor in the 6.3 programs

μ_1 = the population mean relative weight for a particular factor in the 6.2 programs

μ_2 = the population mean relative weight for a particular factor in the 6.3 programs

n_1 = the number in the sample population of the 6.2 programs

n_2 = the number in the sample population of the 6.3 programs

$$S = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2} \qquad \text{(B-5)}$$

S_i = the sample variance for the i^{th} sample

(Mendenhall and Scheaffer, 1973:285-287)

NOTE: $\mu_1 - \mu_2 = 0$ for the test used

C. The general structure of the Simple and Interactive Models was:

5. Simple Model

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \beta_5 X_{i5} + \beta_6 X_{i6} \qquad \text{(B-6)}$$

6. Interactive Model

$$\begin{aligned} Y_i = \beta_0 &+ \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \beta_5 X_{i5} \\ &+ \beta_6 X_{i6} + \beta_7 X_{i1} X_{i2} + \beta_8 X_{i1} X_{i3} + \beta_9 X_{i1} X_{i4} \\ &+ \beta_{10} X_{i1} X_{i5} + \beta_{11} X_{i1} X_{i6} + \beta_{12} X_{i2} X_{i3} \\ &+ \beta_{13} X_{i2} X_{i4} + \beta_{14} X_{i2} X_{i5} + \beta_{15} X_{i2} X_{i6} \\ &+ \beta_{16} X_{i3} X_{i4} + \beta_{17} X_{i3} X_{i5} + \beta_{18} X_{i3} X_{i6} \\ &+ \beta_{19} X_{i4} X_{i5} + \beta_{20} X_{i4} X_{i6} + \beta_{21} X_{i5} X_{i6} \qquad \text{(B-7)} \end{aligned}$$

where for both models

X_{i1} = Cost-Benefit Ratio predictor variable

X_{i2} = Technical Merit predictor variable

X_{i3} = Resource Availability predictor variable

X_{i4} = Likelihood of Success predictor variable

X_{i5} = Time Period predictor variable

X_{i6} = Air Force Need predictor variable

$X_{i1}X_{i2}$ . . . $X_{i5}X_{i6}$ = Two-Way Interactive predictor variables

β_i = beta weight for the i^{th} predictor variable

APPENDIX C

FORTRAN Regression Analysis Program

A complete copy of the regression analysis program used to generate the R^2s, Beta Weights, and Relative Weights from the individual decision responses is included in this appendix.

```
C       POLICY CAPTURING ANALYSIS. EXPAND INPUT DATA (TAPE1) TO
C       CALCULATE INDIVIDUAL REGRESSIONS.
        PROGRAM POLICY(INPUT,OUTPUT,PUNCH,TAPE1,TAPE2)
        DIMENSION XX(64,21),X(64,21),Y(64),B(21),DEMO(60),FMT(8),
       1          FMT2(8),REL(21)
        REWIND 1
        REWIND 2
        NL=51
C       READ RUN CONTROL CARD
C       COLS 1-2: NF - NUMBER OF FACTORS (RIGHT JUSTIFIED IN FIELD)
C       COLS 3-5: ND - NUMBER OF DECISIONS BY EACH RESPONDENT (RIGHT
C                 JUSTIFIED IN FIELD)
C       COLS 6-8: NC - NUMBER OF COLUMNS OF DEMOGRAPHIC DATA TO BE
C                 COPIED TO OUTPUT FILE. MUST BE LEADING CHARACTERS
C                 IN EACH RECORD.
C       COL  9:   IOUT - IF NOT ZERO OR BLANK, WRITE ON TAPE2,IOUT VECTORS
        READ 10,NF,ND,NC,IOUT
        NM=NF
        IF(IOUT.NE.0) NM=IOUT
10      FORMET(I2,2I3,I1)
C       READ FORMAT STATEMENT FOR EACH CASE: DEMOS,DECISIONS,CASE ID
C       SHOULD BE DESCRIBED. USE A1 AS SPECIFICATION FOR DEMOS, F-TYPE
C       FOR DECISIONS, A-TYPE (UP TO A10) FOR CASE ID.
        READ 15,FMT
15      FORMAT(8A10)
        PRINT 12,NF,ND,NC,FMT
12      FORMAT(1H1,"POLICY CAPTURING ANALYSIS PROGRAM"/
       1  1H0,"NUMBER OF FACTORS=",I3,"  NUMBER OF DECISIONS=",I3,
       2  "  NUMBER OF COLUMNS OF DEMOGRAPHICS=",I3/
       3  1H0,"INPUT FORMAT STATEMENT IS: ",8A10)
C       IF EXPANDED FILE REQUESTED, READ OUTPUT FORMAT STATEMENT
        IF(IOUT.EQ.0) GO TO 100
        READ 15,FMT2
```

Figure C-1. FORTRAN Regression Analysis Program

```
      PRINT 13,FMT2
13    FORMAT(1HO,"EXPANDED FILE REQUESTED."/1H ,
     1 "OUTPUT FORMAT STATEMENT IS: ",8A10
C     READ FACTOR CODING. ONE CARD FOR EACH DECISIONS. THE FIRST NF
C     COLUMNS OF EACH CARD CONTAIN ONE-ZERO CODING FOR EACH FACTOR
C     FOR THAT DECISION. THERE MUST BE ND CARDS IN ALL.
100   DO 200 I=1,ND
      READ 20,(XX(I,J),J=1,NM)
20    FORMAT(21F1.0)
      IF(EOF(5LINPUT).EQ.0) GO TO 200
      PRINT *,"INSUFFICIENT FACTOR-CODING CARDS, NEEDED ",ND
      STOP
200   CONTINUE
C     RECODE X() TO +1/-1 FORMAT TO YIELD ZERO MEANS
      DO 300 I=1,ND
      DO 300 J=1,NF
      IF(XX(I,J).EQ.0.) X(I,J)=-1.0
      IF(XX(I,J).EQ.1.0) X(I,J)=1.0
      IF(X(I,J).EQ.-1.0.OR.X(I,J).EQ.1.0) GO TO 300
      PRINT *,"ERROR IN FACTOR CODING FOR DECISION NUMBER ",I
      STOP
300   CONTINUE
C     CALCULATE AND PRINT X'X AS CHECK ON OTHOGONAL DESIGN
      PRINT 30
30    FORMAT(1HO,"X'X MATRIX. SHOULD BE DIAGONAL WITH "
     1 "NUMBER OF DECISIONS ON DIAGONAL")
      DO 500 I=1,NF
      DO 400 J=1,NF
      B(J)=0.0
      DO 400 K=1,ND
      B(J)=B(J)+X(K,I *X(K,J)
400   CONTINUE
      PRINT 40,(B(JJ),JJ=1,NF)
```

Figure C-1 (cont.). FORTRAN Regression Analysis Program

```
40      FORMAT(1H0,21F6.2)
500     CONTINUE
C       CALCULATE CONSTANTS TO USE IN COEFF. GENERATION
        XPXINV=1.0/ND
        SIGX=SQRT(ND-1.0))
C       PROCESS ONE CASE
C       CALCULATE MEAN AND VARIANCE OF Y'S, THE DECISIONS
550     READ(1,FMT) (DEMO(J),J=1,NC),(Y(J),J=1,ND),CASE
        IF(EOF(1).NE.0) GO TO 2000
        YBAR=0.
        SIGY=0.
        DO 600 I=1,ND
        YBAR=YBAR+Y(I)
        SIGY=SIGY+Y(I)**2
600     CONTINUE
        SIGY=SQRT((SIGY-(YBAR**2)/ND)/(ND-1.0))
        YBAR=YBAR/ND
C       COMPUTE COEFFICIENTS, STANDARDIZE THEM, ACCUMULATE R**2
        RSQ=0.
        SIGRAT=SIGX/SIGY
        DO 800 J=1,NF
        B(J)=0.
        DO 700 I=1,ND
        B(J)=B(J)+X(I,J)*Y(I)
700     CONTINUE
        B(J)=XPXINV*B(J)*SIGRAT
        RSQ=RSQ+B(J)**2
800     CONTINUE
C       COMPUTE RELATIVE WEIGHTS
        DO 900 J=1,NF
        REL(J)=B(J)**2/RSQ
900     CONTINUE
C       PRINT AND WRITE RESULTS TO TAPE - THEN GET NEXT CASE
```

Figure C-1 (cont.). FORTRAN Regression Analysis Program

```
      IF(NL.LT.51) GO TO 950
      PRINT 55
      NL=0
55    FORMAT(1H1,"CASE          YBAR   SIGY    RSQ   ",
     1  "BETA WEIGHTS FOLLOWED BY RELATIVE WEIGHTS"/)
950   PRINT 60,CASE,YBAR,SIGY,RSQ,
     1   (B(J),J=1,NP),(REL(J),J=1,NF)
60    FORMAT(1H ,A10,3F7.3/4X,6F7.3/4X,15F7.3/4X,6F7.3/4X,15Fy.3/)
      NL=NL+1
C     WRITE OPTIONAL EXPANDED FILE IF REQUESTED
      IF(IOUT.EQ.0) GO TO 550
      DO 1000 I=1,ND
      WRITE(2,FMT2) (DEMO(J),J=1,NC),(XX(I,J),J=1,NM),Y(I),SIGY,RSQ,
     1  (B(J),J=1,NP),(REL(J),J=1,NF),CASE
1000  CONTINUE
      GO TO 550
C     END OF PROCESSING
2000  CONTINUE
      STOP
      END
```

Figure C-1 (cont.). FORTRAN Regression Analysis Program

APPENDIX D

Simple Versus Interactive Model

This appendix includes a tabulation of the results of equation B-3 in determining whether the simple or the interactive model is more representative of the population for both the 6.2 and 6.3 projects.

TABLE XVI

Simple Versus Interactive Model (6.2 Projects)

Case	Simple R_S^2	Interactive R_I^2	$R_I^2 - R_S^2$ (Actual)	$\Delta R_I^2 - R_S^2$*** (Calculated)
001	.654	.887	.233	.483
002*	.895	.990	.095	.043
003	.835	.897	.062	.440
004	.862	.922	.060	.334
005	.759	.899	.140	.432
006	.895	.953	.058	.201
007	.894	.964	.070	.154
008	.892	.956	.064	.188
009	.930	.980	.050	.085
010	.627	.876	.249	.530
011	.877	.940	.063	.257
012	.882	.954	.072	.198
013	.891	.952	.061	.205
014*	.793	.969	.176	.133
015	.989	.995	.006	.021
016	.979	.989	.010	.047

* Indicates Significant Interactive Model
*** Refer to Appendix B, equation B-3

TABLE XVI (cont.)

Simple Versus Interactive Model (6.2 Projects)

Case	Simple R_S^2	Interactive R_I^2	$R_I^2 - R_S^2$ (Actual)	$\triangle R_I^2 - R_S^2$*** (Calculated)
017*	.875	.957	.082	.061
018	.982	.992	.010	.034
019**	.515	.693	.178	1.313
020	.806	.913	.107	.372
021	.739	.946	.207	.231
022	.748	.870	.122	.556
023	.896	.978	.082	.094
024	.877	.966	.089	.145
025	.900	.977	.077	.098
026	.928	.985	.057	.064
027	.688	.865	.177	.577
028	.873	.953	.080	.201
029	.977	.988	.011	.051
030	.838	.928	.090	.308
031	.703	.883	.180	.500

* Indicates Significant Interactive Model
** Indicates Interactive Model Is Not Statistically Different From Zero
*** Refer to Appendix B, equation B-3

TABLE XVI (cont.)

Simple Versus Interactive Model (6.2 Projects)

Case	Simple R_S^2	Interactive R_I^2	$R_I^2 - R_S^2$ (Actual)	$\Delta R_I^2 - R_S^2$*** (Calculated)
032	.885	.978	.093	.094
033**	.602	.841	.239	.795
034	.784	.948	.164	.222
035	.699	.855	.156	.620
036	.897	.949	.052	.218
037	.887	.932	.045	.291
038	.713	.878	.165	.522
039*	.836	.971	.135	.124
040	.983	.988	.005	.051
041	.871	.969	.098	.133
042*	.867	.984	.117	.068
043	.782	.930	.148	.299
044	.857	.934	.077	.282
045	.752	.889	.137	.475
046	.733	.862	.129	.590

* Indicates Significant Interactive Model
** Indicates Interactive Model Is Not Statistically Different From Zero
*** Refer to Appendix B, equation B-3

TABLE XVI (cont.)

Simple Versus Interactive Model (6.2 Projects)

Case	Simple R_S^2	Interactive R_I^2	$R_I^2 - R_S^2$ (Actual)	$\Delta R_I^2 - R_S^2$ (Calculated)***
047	.898	.934	.036	.282
048	.987	.992	.005	.034
049*	.745	.953	.208	.200
050	.792	.931	.139	.295
051	.925	.970	.045	.128
052**	.530	.755	.225	1.047
053	.698	.913	.215	.372
054	.794	.928	.134	.308
055	.989	.989	.000	.047
056	.898	.962	.064	.163
057	.818	.934	.116	.282
058**	.371	.681	.307	1.363
059*	.817	.978	.161	.094
060	.737	.910	.173	.385
061	.950	.970	.020	.128

* Indicates Significant Interactive Model
** Indicates Interactive Model Is Not Statistically Different From Zero
*** Refer to Appendix B, equation B-3

TABLE XVI (cont.)

Simple Versus Interactive Model (6.2 Projects)

Case	Simple R_S^2	Interactive R_I^2	$R_I^2 - R_S^2$ (Actual)	$\Delta R_I^2 - R_S^2$*** (Calculated)
062	.735	.949	.214	.218
063**	.552	.821	.269	.765
064	.867	.929	.062	.304
065	.838	.942	.104	.248
066	.909	.950	.049	.214
067	.843	.920	.077	.342
068	.929	.956	.027	.188
069	1.000	1.000	.000	.000

** Indicates Interactive Model Is Not Statistically Different From Zero
*** Refer to Appendix B, equation B-3

TABLE XVII

Simple Versus Interactive Model (6.3 Projects)

Case	Simple R_S^2	Interactive R_I^2	$R_I^2 - R_S^2$ (Actual)	$\Delta R_I^2 - R_S^2$ *** (Calculated)
001	.926	.966	.040	.145
002	.646	.896	.250	.445
003	.781	.933	.152	.286
004	.906	.965	.059	.150
005	.897	.970	.073	.128
006	.938	.978	.040	.094
007	.767	.914	.147	.368
008	.808	.857	.049	.611
009	.924	.956	.032	.188
010*	.934	.989	.055	.047
011	.916	.982	.066	.077
012	.966	.975	.009	.107
013	.717	.907	.190	.398
014	.920	.984	.064	.068
015	.956	.980	.024	.086
016	.826	.929	.103	.304

* Indicates Significant Interactive Model
*** Refer to Appendix B, equation B-3

TABLE XVII (cont.)

Simple Versus Interactive Model (6.3 Projects)

Case	Simple R_S^2	Interactive R_I^2	$R_I^2 - R_S^2$ (Actual)	$\Delta R_I^2 - R_S^2$ (Calculated)***
017	.756	.916	.160	.359
018*	.692	.969	.277	.133
019**	.629	.844	.215	.667
020	.907	.962	.055	.162
021	.916	.973	.057	.115
022	.766	.914	.148	.368
023	.763	.891	.128	.466
024	.788	.907	.119	.398
025	.860	.927	.067	.312
026	.850	.949	.099	.218
027	.926	.941	.015	.252
028	.992	.992	.000	.034
029	.919	.962	.043	.162
030	.652	.883	.231	.500
031	.922	.969	.047	.132

* Indicates Significant Interactive Model
** Indicates Interactive Model Is Not Statistically Different From Zero
*** Refer to Appendix B, equation B-3

APPENDIX E

Code Assignment Letters and Feedback

This appendix includes a copy of the letters used to assign the specific code to the model associated with those individuals who requested feedback and the results of the 6.2 and 6.3 individual and group models.

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (ATC)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

REPLY TO ATTN OF: ENS

SUBJECT: R&D Project-Selection Decision Making Exercise (6.2 Programs)

TO:

1. The response rate for this decision making exercise was excellent. The preliminary results indicated that all of the individuals who completed the instrument were consistent in their decision making process. In other words, the model formulated for each individual was statistically significant.

2. I have assigned a specific code to each individual who requested feedback concerning his model. Your personal code is _____. This code should be retained to identify your specific model when the final analysis is completed.

3. Again, thank you for your efforts. I plan to send you the final results of the decision making exercise in the near future (NLT August 1979).

Terry L. Brooks
TERRY L. BROOKS, Capt, USAF
Graduate Student, GSM-79S
School of Engineering

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (ATC)
WRIGHT-PATTERSON AIR FORCE BASE OHIO 45433

REPLY TO ATTN OF: ENS

SUBJECT: R&D Project-Selection Decision Making Exercise (6.3 Programs)

TO:

1. Thank you for completing the 6.3 program instrument. The response rate was better than the rate for the 6.2 program. The preliminary results indicated that each individual was consistent in the decision making process. All individual models formulated were statistically significant.

2. I have assigned a specific code to each individual who requested feedback concerning his model. Your personal code is _____. This code should be retained to identify your specific model when the final analysis is completed.

3. Again, thank you for your cooperation. The final results will be sent out by the middle of August 1979.

Terry L. Brooks

Terry L. Brooks, Capt, USAF
Graduate Student, GSM-79S
School of Engineering

TABLE XVIII

Management Level and Division Models (6.2 Projects)

Regression Group	Cost-Benefit Ratio	Technical Merit	Resource Availability	Likelihood of Success	Time Period	Air Force Need
Entire Laboratory	.069*	.305	.045	.043	.017	.522
Command Section	.097	.319	.001	.059	.030	.494
Staff	.104	.289	.081	.047	.042	.439
Division	.052	.326	.041	.020	.011	.551
Branch	.043	.293	.043	.058	.015	.547
Group	.081	.310	.041	.037	.015	.517
Entire Division Population	.064	.306	.042	.042	.015	.532
FX Division	.055	.441	.047	.030	.018	.409

* Regression Relative Weights

TABLE XVIII (cont.)

Management Level and Division Models (6.2 Projects)

Regression Group	Cost-Benefit Ratio	Technical Merit	Resource Availability	Likelihood of Success	Time Period	Air Force Need
FG Division	.084*	.325	.053	.070	.017	.451
FE Division	.072	.117	.022	.016	.008	.766
FB Division	.038	.236	.038	.061	.010	.618

* Regression Relative Weights

TABLE XIX

Individual Models (6.2 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
001	Regression	.226*	.115	.029	.074	.094	.462
	Subjective	.20**	.10	.15	.25	.05	.25
002	Regression	.163	.163	.007	.016	.010	.572
	Subjective	.20	.15	.05	.10	.25	.25
003	Regression	.002	.556	.048	.000	.017	.377
	Subjective	--	--	--	--	--	--
004	Regression	.126	.220	.447	.089	.107	.010
	Subjective	--	--	--	--	--	--
005	Regression	.009	.439	.027	.001	.020	.504
	Subjective	.15	.30	.10	.05	.05	.35
006	Regression	.034	.522	.000	.102	.034	.307
	Subjective	.20	.40	.05	.10	.10	.15
007	Regression	.046	.542	.010	.022	.046	.334
	Subjective	.19	.40	.07	.10	.03	.21
008	Regression	.051	.382	.020	.001	.013	.534
	Subjective	.20	.30	.10	.05	.05	.30

* Regression Relative Weights
** Subjective Weights

TABLE XIX (cont.)

Individual Models (6.2 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
009	Regression	.013*	.388	.027	.020	.027	.525
	Subjective	.10**	.30	.10	.10	.10	.30
010	Regression	.027	.197	.044	.123	.014	.595
	Subjective	.15	.19	.17	.13	.11	.25
011	Regression	.000	.496	.048	.039	.097	.320
	Subjective	.15	.21	.15	.18	.10	.21
012	Regression	.001	.010	.018	.073	.000	.897
	Subjective	.15	.20	.05	.05	.05	.50
013	Regression	.020	.139	.044	.014	.078	.705
	Subjective	.10	.20	.10	.20	.10	.30
014	Regression	.249	.383	.090	.048	.020	.211
	Subjective	.25	.20	.05	.15	.05	.30
015	Regression	.030	.705	.030	.078	.007	.150
	Subjective	.10	.40	.10	.15	.05	.20
016	Regression	.007	.013	.002	.007	.002	.970
	Subjective	.00	.00	.00	.00	.00	1.00

* Regression Relative Weights
** Subjective Weights

TABLE XIX (cont.)

Individual Models (6.2 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
017	Regression	.037*	.066	.102	.066	.037	.693
	Subjective	.15**	.15	.10	.15	.10	.35
018	Regression	.008	.921	.008	.005	.015	.044
	Subjective	.05	.40	.10	.15	.05	.25
019	Regression	.000	.699	.025	.003	.000	.273
	Subjective	.20	.40	.05	.15	.05	.15
020	Regression	.169	.127	.091	.091	.012	.509
	Subjective	.20	.10	.10	.10	.10	.40
021	Regression	.428	.154	.112	.026	.076	.203
	Subjective	.25	.25	.10	.10	.10	.20
022	Regression	.046	.200	.079	.013	.000	.660
	Subjective	.15	.25	.15	.10	.05	.30
023	Regression	.024	.404	.012	.069	.000	.491
	Subjective	.15	.20	.15	.15	.10	.25
024	Regression	.057	.446	.008	.057	.019	.413
	Subjective	.20	.25	.10	.15	.10	.20

* Regression Relative Weights
** Subjective Weights

TABLE XIX (cont.)

Individual Models (6.2 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
025	Regression	.117*	.152	.040	.031	.031	.627
	Subjective	.15**	.23	.19	.12	.08	.27
026	Regression	.378	.102	.030	.267	.005	.218
	Subjective	.25	.10	.10	.25	.05	.25
027	Regression	.149	.076	.194	.001	.027	.553
	Subjective	.15	.20	.20	.10	.10	.25
028	Regression	.113	.366	.085	.085	.085	.266
	Subjective	.10	.35	.15	.15	.05	.20
029	Regression	.018	.407	.229	.045	.045	.255
	Subjective	.10	.30	.20	.10	.10	.20
030	Regression	.002	.088	.002	.179	.016	.714
	Subjective	.10	.15	.10	.15	.05	.45
031	Regression	.003	.210	.007	.026	.012	.743
	Subjective	.10	.25	.10	.15	.05	.35
032	Regression	.025	.349	.042	.001	.007	.576
	Subjective	.05	.24	.19	.14	.08	.30

* Regression Relative Weights
** Subjective Weights

TABLE XIX (cont.)

Individual Models (6.2 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
033	Regression	.059*	.059	.015	.000	.007	.862
	Subjective	.20**	.01	.02	.02	.05	.70
034	Regression	.000	.222	.037	.110	.015	.616
	Subjective	.10	.20	.20	.15	.05	.30
035	Regression	.108	.155	.039	.069	.108	.522
	Subjective	.15	.20	.05	.05	.05	.50
036	Regression	.028	.519	.151	.021	.010	.272
	Subjective	.08	.30	.20	.12	.05	.25
037	Regression	.136	.251	.215	.001	.020	.378
	Subjective	.15	.25	.20	.05	.05	.30
038	Regression	.088	.088	.198	.002	.000	.624
	Subjective	.10	.15	.25	.15	.05	.30
039	Regression	.133	.039	.013	.050	.007	.758
	Subjective	.25	.13	.07	.12	.03	.40
040	Regression	.001	.019	.000	.006	.000	.974
	Subjective	.05	.15	.05	.10	.15	.50

* Regression Relative Weights
** Subjective Weights

TABLE XIX (cont.)

Individual Models (6.2 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
041	Regression	.041*	.445	.021	.102	.021	.371
	Subjective	.10**	.30	.05	.20	.05	.30
042	Regression	.213	.122	.006	.056	.001	.603
	Subjective	.22	.22	.07	.15	.04	.30
043	Regression	.114	.168	.140	.038	.008	.532
	Subjective	.20	.30	.00	.10	.00	.40
044	Regression	.219	.577	.024	.005	.009	.165
	Subjective	.21	.40	.10	.05	.05	.19
045	Regression	.013	.252	.013	.060	.004	.657
	Subjective	.10	.20	.10	.15	.15	.30
046	Regression	.075	.000	.033	.134	.002	.755
	Subjective	.12	.05	.06	.25	.01	.51
047	Regression	.129	.066	.042	.024	.066	.674
	Subjective	.20	.12	.18	.15	.10	.25
048	Regression	.275	.155	.099	.034	.006	.430
	Subjective	--	--	--	--	--	--

* Regression Relative Weights
** Subjective Weights

TABLE XIX (cont.)

Individual Models (6.2 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Availability	Likelihood of Success	Time Period	Air Force Need
049	Regression	.215*	.138	.044	.013	.105	.484
	Subjective	.10**	.05	.20	.10	.05	.50
050	Regression	.011	.160	.011	.086	.003	.728
	Subjective	--	--	--	--	--	--
051	Regression	.007	.118	.041	.118	.007	.709
	Subjective	.10	.20	.15	.20	.10	.25
052	Regression	.084	.518	.036	.195	.013	.153
	Subjective	.10	.40	.20	.15	.10	.05
053	Regression	.368	.082	.009	.001	.001	.539
	Subjective	.30	.20	.05	.05	.10	.30
054	Regression	.097	.319	.001	.059	.030	.494
	Subjective	--	--	--	--	--	--
055	Regression	.099	.176	.044	.275	.011	.396
	Subjective	.20	.25	.20	.10	.05	.20
056	Regression	.257	.442	.100	.064	.016	.121
	Subjective	.20	.25	.20	.10	.05	.20

* Regression Relative Weights
** Subjective Weights

TABLE XIX (cont.)

Individual Models (6.2 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
057	Regression	.081*	.450	.130	.096	.113	.130
	Subjective	.10**	.35	.20	.15	.10	.10
058	Regression	.000	.449	.340	.038	.038	.135
	Subjective	.15	.15	.20	.20	.10	.20
059	Regression	.035	.603	.001	.002	.001	.358
	Subjective	.20	.30	.08	.13	.04	.25
060	Regression	.000	.097	.049	.032	.032	.791
	Subjective	.20	.25	.10	.10	.10	.25
061	Regression	.037	.337	.057	.037	.016	.515
	Subjective	.18	.20	.15	.12	.10	.25
062	Regression	.006	.353	.006	.014	.000	.622
	Subjective	.15	.35	.00	.00	.00	.50
063	Regression	.009	.003	.360	.084	.030	.513
	Subjective	.10	.15	.30	.15	.00	.30
064	Regression	.173	.058	.000	.000	.039	.729
	Subjective	.30	.25	.05	.10	.05	.25

* Regression Relative Weights
** Subjective Weights

TABLE XIX (cont.)

Individual Models (6.2 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
065	Regression	.091*	.380	.091	.091	.150	.198
	Subjective	.15**	.20	.10	.15	.10	.30
066	Regression	.037	.307	.004	.073	.000	.578
	Subjective	.20	.25	.00	.20	.05	.30
067	Regression	.085	.851	.038	.021	.002	.002
	Subjective	.20	.25	.20	.15	.10	.10
068	Regression	.072	.540	.011	.114	.011	.252
	Subjective	.10	.40	.06	.15	.04	.25
069	Regression	.200	.200	.050	.050	.050	.450
	Subjective	.20	.20	.10	.10	.10	.30

* Regression Relative Weights
** Subjective Weights

TABLE XX

Management Level and Division Models (6.3 Projects)

Regression Group	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
Entire Laboratory	.114*	.237	.047	.042	.041	.519
Command Section	.060	.380	.004	.010	.005	.541
Staff	.099	.039	.142	.088	.063	.569
Division	.076	.340	.042	.024	.014	.505
DEPEM	.146	.132	.045	.069	.119	.489
ADPO	.133	.276	.040	.038	.037	.477
Entire Division Population	.120	.261	.042	.022	.042	.495
FX Division	.151	.488	.073	.032	.017	.239

* Regression Relative Weights

TABLE XX (cont.)

Management Level and Division Models (6.3 Projects)

Regression Group	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
FG Division	.090*	.332	.033	.023	.047	.474
FE Division	.231	.113	.058	.098	.039	.461
FB Division	.070	.239	.029	.021	.046	.594
FI Division	.102	.212	.020	.102	.062	.503

* Regression Relative Weights

TABLE XXI

Individual Models (6.3 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
001	Regression	.073*	.121	.004	.008	.000	.793
	Subjective	--	--	--	--	--	--
002	Regression	.202	.073	.129	.008	.073	.516
	Subjective	.30**	.15	.05	.05	.15	.30
003	Regression	.039	.660	.002	.010	.022	.267
	Subjective	.10	.25	.18	.17	.10	.20
004	Regression	.351	.351	.033	.052	.063	.150
	Subjective	.25	.25	.10	.15	.10	.15
005	Regression	.015	.376	.102	.015	.087	.406
	Subjective	.10	.20	.15	.10	.15	.30
006	Regression	.108	.061	.168	.091	.243	.330
	Subjective	.10	.10	.20	.10	.20	.30
007	Regression	.117	.011	.338	.011	.057	.467
	Subjective	.20	.10	.20	.15	.05	.30
008	Regression	.035	.078	.078	.106	.078	.626
	Subjective	.15	.05	.20	.15	.05	.40

* Regression Relative Weights
** Subjective Weights

TABLE XXI (cont.)

Individual Models (6.3 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
009	Regression	.004*	.257	.024	.039	.012	.664
	Subjective	.20**	.20	.10	.10	.10	.30
010	Regression	.158	.042	.051	.141	.061	.548
	Subjective	.20	.10	.10	.20	.10	.30
011	Regression	.293	.008	.090	.177	.033	.399
	Subjective	.25	.03	.15	.20	.07	.30
012	Regression	.220	.103	.001	.005	.005	.665
	Subjective	.26	.15	.09	.04	.02	.44
013	Regression	.065	.445	.198	.001	.001	.291
	Subjective	.15	.25	.20	.05	.10	.25
014	Regression	.007	.275	.012	.012	.025	.668
	Subjective	.10	.20	.10	.15	.15	.30
015	Regression	.073	.149	.007	.017	.023	.731
	Subjective	.19	.24	.09	.14	.05	.29
016	Regression	.037	.395	.087	.000	.020	.462
	Subjective	.10	.20	.15	.10	.05	.40

* Regression Relative Weights
** Subjective Weights

TABLE XXI (cont.)

Individual Models (6.3 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
017	Regression	.053*	.672	.099	.099	.022	.053
	Subjective	.20**	.40	.15	.15	.05	.05
018	Regression	.102	.212	.020	.102	.062	.503
	Subjective	.20	.15	.10	.25	.00	.30
019	Regression	.034	.302	.086	.034	.109	.435
	Subjective	.05	.22	.15	.17	.16	.25
020	Regression	.041	.069	.102	.373	.041	.373
	Subjective	.15	.15	.10	.20	.05	.35
021	Regression	.264	.380	.001	.001	.006	.349
	Subjective	.25	.20	.10	.05	.10	.30
022	Regression	.061	.112	.005	.000	.179	.642
	Subjective	.20	.15	.10	.10	.20	.25
023	Regression	.041	.707	.001	.008	.001	.243
	Subjective	.05	.50	.05	.10	.05	.25
024	Regression	.215	.360	.074	.074	.036	.241
	Subjective	.20	.20	.10	.15	.10	.15

* Regression Relative Weights
** Subjective Weights

TABLE XXI (cont.)

Individual Models (6.3 Projects)

Case	Type Model	Cost-Benefit Ratio	Technical Merit	Resource Availability	Likelihood of Success	Time Period	Air Force Need
025	Regression	.030*	.095	.015	.030	.022	.808
	Subjective	--	--	--	--	--	--
026	Regression	.307	.040	.110	.177	.059	.307
	Subjective	.25**	.10	.10	.20	.05	.30
027	Regression	.315	.315	.027	.132	.027	.184
	Subjective	.20	.25	.10	.15	.10	.20
028	Regression	.230	.179	.065	.065	.039	.422
	Subjective	.23	.18	.12	.12	.06	.29
029	Regression	.036	.044	.064	.044	.064	.747
	Subjective	.15	.05	.10	.15	.05	.50
030	Regression	.143	.218	.000	.060	.040	.539
	Subjective	.10	.20	.05	.40	.05	.20
031	Regression	.142	.491	.007	.003	.007	.351
	Subjective	.15	.30	.10	.15	.05	.25

* Regression Relative Weights
** Subjective Weights

APPENDIX F

Sequence of Cue-Value Combinations

This appendix includes the different cue-value combinations for the 32 R&D project-selection decisions.

Project Number	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
1	Acc*	Acc	Acc	Ex**	Acc	Acc
2	Ex	Acc	Ex	Acc	Acc	Ex
3	Acc	Ex	Acc	Acc	Ex	Ex
4	Ex	Acc	Acc	Ex	Ex	Acc
5	Acc	Ex	Ex	Ex	Ex	Ex
6	Ex	Ex	Ex	Acc	Acc	Acc
7	Ex	Ex	Ex	Ex	Ex	Acc
8	Acc	Ex	Ex	Acc	Ex	Acc
9	Acc	Ex	Acc	Acc	Acc	Acc
10	Ex	Acc	Ex	Ex	Acc	Acc
11	Acc	Acc	Ex	Ex	Acc	Ex
12	Acc	Ex	Ex	Acc	Acc	Ex
13	Ex	Ex	Acc	Ex	Acc	Acc
14	Acc	Ex	Acc	Ex	Ex	Acc
15	Acc	Ex	Ex	Ex	Acc	Acc
16	Ex	Acc	Ex	Ex	Ex	Ex
17	Ex	Ex	Ex	Acc	Ex	Ex
18	Acc	Acc	Acc	Ex	Ex	Ex

* Acc = Acceptable
** Ex = Excellent

Figure P-1. Sequence of Cue-Value Combinations

Project Number	Cost-Benefit Ratio	Technical Merit	Resource Avail-ability	Likeli-hood of Success	Time Period	Air Force Need
19	Acc*	Acc	Ex**	Acc	Ex	Ex
20	Ex	Acc	Ex	Acc	Ex	Acc
21	Acc	Acc	Acc	Acc	Ex	Acc
22	Ex	Ex	Ex	Ex	Acc	Ex
23	Ex	Ex	Acc	Ex	Ex	Ex
24	Ex	Acc	Acc	Acc	Ex	Ex
25	Acc	Acc	Ex	Ex	Ex	Acc
26	Ex	Acc	Acc	Ex	Acc	Ex
27	Acc	Ex	Acc	Ex	Acc	Ex
28	Ex	Ex	Acc	Acc	Acc	Ex
29	Acc	Acc	Ex	Acc	Acc	Acc
30	Acc	Acc	Acc	Acc	Acc	Ex
31	Ex	Acc	Acc	Acc	Acc	Acc
32	Ex	Ex	Acc	Acc	Ex	Acc

* Acc = Acceptable
** Ex = Excellent

Figure P-1 (cont.). Sequence of Cue-Value Combinations

APPENDIX G

Data Coding Process

This appendix shows the coding process used to prepare the raw data for analysis.

* CARD COLUMNS *

1	2	5 Through 69	72 Through 74
Demographics		Decisions	Case Numbers
D	D	D	C
E	E	E	A
M	M	C	S
O	O		E
1	2		

Figure G-1. Example of Data Coding Process. The DEMO and CASE variables were alpha/numerically coded whereas the DEC variables were numerically coded.

APPENDIX H

Factor Pairwise T-Tests

This appendix is made up of the tables used to calculate the t values for the pairwise t-test on the factors. The difference between the subjective weight and the regression weight for each individual per factor was the basis of the test.

TABLE XXII

Cost-Benefit Ratio (6.2 Projects)

Case	Subjective Weights	Regression Weights	Difference
001	.20	.226	-.026
002	.20	.163	.037
005	.15	.009	.141
006	.20	.034	.166
007	.19	.046	.144
008	.20	.051	.149
009	.10	.013	.087
010	.15	.027	.123
011	.15	.000	.150
012	.15	.001	.149
013	.10	.020	.080
014	.25	.249	.001
015	.10	.030	.070
016	.00	.007	-.007
017	.15	.037	.113
018	.05	.008	.042
019	.20	.000	.200
020	.20	.169	.031
021	.25	.428	-.178
022	.15	.046	.104
023	.15	.024	.126
024	.20	.057	.143
025	.15	.117	.033
026	.25	.378	-.128
027	.15	.149	.001
028	.10	.113	-.013
029	.10	.018	.082
030	.10	.002	.098
031	.10	.003	.097
032	.05	.025	.025
033	.20	.059	.141
034	.10	.000	.100
035	.15	.108	.042
036	.08	.028	.052
037	.15	.136	.014
038	.10	.088	.012
039	.25	.133	.117
040	.05	.001	.049
041	.10	.041	.059
042	.22	.213	.007
043	.20	.114	.086
044	.21	.219	-.009
045	.10	.013	.087

TABLE XXII (cont.)

Cost-Benefit Ratio (6.2 Projects)			
Case	Subjective Weights	Regression Weights	Difference
046	.12	.075	.045
047	.20	.129	.071
049	.10	.215	-.115
051	.10	.007	.093
052	.10	.084	.016
053	.30	.368	-.068
055	.15	.099	.051
056	.20	.257	-.057
057	.10	.081	.019
058	.15	.000	.150
059	.20	.035	.165
060	.20	.000	.200
061	.18	.037	.143
062	.15	.006	.144
063	.10	.009	.091
064	.30	.173	.127
065	.15	.091	.059
066	.20	.037	.163
067	.20	.085	.115
068	.10	.072	.028
069	.20	.200	.000
			= 4.237

MEAN = .0662
STD DEV = .0768
n = 64

TABLE XXIII

Technical Merit (6.2 Projects)

Case	Subjective Weights	Regression Weights	Difference
001	.10	.115	-.015
002	.15	.163	-.013
005	.30	.439	-.139
006	.40	.522	-.122
007	.40	.542	-.142
008	.30	.382	-.082
009	.30	.388	-.088
010	.19	.197	-.007
011	.21	.496	-.286
012	.20	.010	.190
013	.20	.139	.061
014	.20	.383	-.183
015	.40	.705	-.305
016	.00	.013	-.013
017	.15	.066	.084
018	.40	.921	-.521
019	.40	.699	-.299
020	.10	.127	-.027
021	.25	.154	.096
022	.25	.200	.050
023	.20	.404	-.204
024	.25	.446	-.196
025	.23	.152	.078
026	.10	.102	-.002
027	.20	.076	.124
028	.35	.366	-.016
029	.30	.407	-.107
030	.15	.088	.062
031	.25	.210	.040
032	.24	.349	-.109
033	.01	.059	-.049
034	.20	.222	-.022
035	.20	.155	.045
036	.30	.519	-.219
037	.25	.251	-.001
038	.15	.088	.062
039	.13	.039	.091
040	.15	.019	.131
041	.30	.445	-.145
042	.22	.122	.098
043	.30	.168	.132
044	.40	.577	-.177
045	.20	.252	-.052

TABLE XXIII (cont.)

Technical Merit (6.2 Proje

Case	Subjective Weights	Regression Weights
046	.05	.000
047	.12	.066
049	.05	.138
051	.20	.118
052	.40	.518
053	.20	.082
055	.20	.176
056	.25	.442
057	.35	.450
058	.15	.449
059	.30	.603
060	.25	.097
061	.20	.337
062	.35	.353
063	.15	.003
064	.25	.058
065	.20	.380
066	.25	.307
067	.25	.851
068	.40	.540
069	.20	.200

MEAN = -.0562
STD DEV = .1573
n = 64

TABLE XXIV

	Resource Availability (6.2 Pr	
Case	Subjective Weights	Regression Weights
001	.15	.029
002	.05	.077
005	.10	.027
006	.05	.000
007	.07	.010
008	.10	.020
009	.10	.027
010	.17	.044
011	.15	.048
012	.05	.018
013	.10	.044
014	.05	.090
015	.10	.030
016	.00	.002
017	.10	.102
018	.10	.008
019	.05	.025
020	.10	.091
021	.10	.112
022	.15	.079
023	.15	.012
024	.10	.008
025	.19	.040
026	.10	.030
027	.20	.194
028	.15	.085
029	.20	.229
030	.10	.002
031	.10	.007
032	.19	.042
033	.02	.015
034	.20	.037
035	.05	.039
036	.20	.151
037	.20	.215
038	.25	.198
039	.07	.013
040	.05	.000
041	.05	.021
042	.07	.006
043	.00	.140
044	.10	.024
045	.10	.013

TABLE XXIV (cont.)

Case	Subjective Weights	Regression Weights	Difference
	Resource Availability (6.2 Projects)		
046	.06	.033	.027
047	.18	.042	.138
049	.20	.044	.156
051	.15	.041	.109
052	.20	.036	.164
053	.05	.009	.041
055	.10	.044	.056
056	.20	.100	.100
057	.20	.130	.070
058	.20	.340	-.140
059	.08	.001	.079
060	.10	.049	.051
061	.15	.057	.093
062	.00	.006	-.006
063	.30	.360	-.060
064	.05	.000	.050
065	.10	.091	.009
066	.00	.004	-.004
067	.20	.038	.162
068	.06	.011	.049
069	.10	.050	.050
			= 3.528

MEAN = .0551
STD DEV = .0623
n = 64

TABLE XXV

Likelihood of Success (6.2 Projects)			
Case	Subjective Weights	Regression Weights	Difference
001	.25	.074	.176
002	.10	.016	.084
005	.05	.001	.049
006	.10	.102	-.002
007	.10	.022	.078
008	.05	.001	.049
009	.10	.020	.080
010	.13	.123	.007
011	.18	.039	.141
012	.05	.073	-.023
013	.20	.014	.186
014	.15	.048	.102
015	.15	.078	.072
016	.00	.007	.143
017	.15	.066	.084
018	.15	.005	.145
019	.15	.003	.147
020	.10	.091	.009
021	.10	.026	.074
022	.10	.013	.087
023	.15	.069	.081
024	.15	.057	.093
025	.12	.031	.089
026	.25	.267	-.017
027	.10	.001	.099
028	.15	.085	.065
029	.10	.045	.055
030	.15	.179	-.029
031	.15	.026	.124
032	.14	.001	.139
033	.02	.000	.020
034	.15	.110	.040
035	.05	.069	-.019
036	.12	.021	.099
037	.05	.001	.049
038	.15	.002	.148
039	.12	.050	.070
040	.10	.006	.094
041	.20	.102	.098
042	.15	.056	.094
043	.10	.038	.062
044	.05	.005	.045
045	.15	.060	.090

TABLE XXV (cont.)

Likelihood of Success (6.2 Projects)			
Case	Subjective Weights	Regression Weights	Difference
046	.25	.134	.116
047	.15	.024	.126
049	.10	.013	.087
051	.20	.118	.082
052	.15	.195	-.045
053	.05	.001	.049
055	.25	.275	-.025
056	.10	.064	.036
057	.15	.096	.054
058	.20	.038	.162
059	.13	.002	.128
060	.10	.032	.068
061	.12	.037	.083
062	.00	.014	-.014
063	.15	.084	.066
064	.10	.000	.100
065	.15	.091	.059
066	.20	.073	.127
067	.15	.021	.129
068	.15	.114	.036
069	.10	.050	.050
			= 4.751

MEAN = .0742
STD DEV = .0526
n = 64

TABLE XXVI

Time Period (6.2 Projects)			
Case	Subjective Weights	Regression Weights	Difference
001	.05	.094	-.044
002	.25	.010	.240
005	.05	.020	.030
006	.10	.034	.066
007	.03	.046	-.016
008	.05	.013	.037
009	.10	.027	-.170
010	.11	.014	.096
011	.10	.097	.003
012	.05	.000	.050
013	.10	.078	.022
014	.05	.020	.030
015	.05	.007	.043
016	.00	.002	-.002
017	.10	.037	.063
018	.05	.015	.035
019	.05	.000	.050
020	.10	.012	.088
021	.10	.076	.024
022	.05	.000	.050
023	.10	.000	.100
024	.10	.019	.081
025	.08	.031	.049
026	.05	.005	.045
027	.10	.027	.073
028	.05	.085	-.035
029	.10	.045	.055
030	.05	.016	.034
031	.05	.012	.038
032	.08	.007	.010
033	.05	.007	.043
034	.05	.015	.035
035	.05	.108	-.058
036	.05	.010	.040
037	.05	.020	.030
038	.05	.000	.050
039	.03	.007	.023
040	.15	.000	.150
041	.05	.021	.029
042	.04	.001	.039
043	.00	.008	-.008
044	.05	.009	.041
045	.15	.004	.146

TABLE XXVI (cont.)

Time Period (6.2 Projects)

Case	Subjective Weights	Regression Weights	Difference
046	.01	.002	.008
047	.10	.066	.034
049	.05	.105	-.055
051	.10	.007	.093
052	.10	.013	.087
053	.10	.001	.099
055	.05	.011	.039
056	.05	.016	.034
057	.10	.113	-.013
058	.10	.038	.062
059	.04	.001	.039
060	.10	.032	.068
061	.10	.016	.084
062	.00	.00	.000
063	.00	.030	-.030
064	.05	.039	.011
065	.10	.150	-.050
066	.05	.000	.050
067	.10	.002	.098
068	.04	.011	.029
069	.10	.050	.050
			= 2.442

MEAN = .0382
STD DEV = .0561
n = 64

TABLE XXVII

Air Force Need (6.2 Projects)

Case	Subjective Weights	Regression Weights	Difference
001	.25	.462	-.212
002	.25	.572	-.322
005	.35	.504	-.154
006	.15	.307	-.157
007	.21	.334	-.124
008	.30	.534	-.234
009	.30	.525	-.225
010	.25	.595	-.345
011	.21	.320	-.110
012	.50	.897	-.397
013	.30	.705	-.405
014	.30	.211	.089
015	.20	.150	.050
016	1.00	.970	.030
017	.35	.693	-.343
018	.25	.044	.206
019	.15	.273	-.123
020	.40	.509	-.109
021	.20	.203	-.003
022	.30	.660	-.360
023	.25	.491	-.241
024	.20	.413	-.213
025	.27	.627	-.357
026	.25	.218	.032
027	.25	.553	-.303
028	.20	.266	-.066
029	.20	.255	-.055
030	.45	.714	-.291
031	.35	.743	-.393
032	.30	.576	-.276
033	.70	.862	-.162
034	.30	.616	-.316
035	.50	.522	-.022
036	.25	.272	-.022
037	.30	.378	-.078
038	.30	.624	-.324
039	.40	.758	-.358
040	.50	.974	-.474
041	.30	.371	-.071
042	.30	.603	-.303
043	.40	.532	-.132
044	.19	.165	.025
045	.30	.657	-.357

TABLE XXVII (cont.)

Air Force Need (6.2 Projects)			
Case	Subjective Weights	Regression Weights	Difference
046	.51	.755	-.245
047	.25	.674	-.424
049	.50	.484	.016
051	.25	.709	-.459
052	.05	.153	-.103
053	.30	.539	-.239
055	.25	.396	-.146
056	.20	.121	.079
057	.10	.130	-.030
058	.20	.135	.065
059	.25	.358	-.108
060	.25	.791	-.541
061	.25	.515	-.265
062	.50	.622	-.122
063	.30	.513	-.213
064	.25	.729	-.479
065	.30	.198	.102
066	.30	.578	-.278
067	.10	.002	.098
068	.25	.252	-.002
069	.30	.450	-.150
			= -11.449

MEAN = -.1789
STD DEV = .1707
n = 64

TABLE XXVIII

Cost-Benefit Ratio (6.3 Projects)

Case	Subjective Weights	Regression Weights	Difference
002	.30	.202	.098
003	.10	.039	.061
004	.25	.351	-.101
005	.10	.015	.085
006	.10	.108	-.008
007	.20	.117	.083
008	.15	.035	.115
009	.20	.004	.196
010	.20	.158	.042
011	.25	.293	-.043
012	.26	.220	.040
013	.15	.065	.085
014	.10	.007	.093
015	.19	.073	.117
016	.10	.037	.063
017	.20	.053	.147
018	.20	.102	.098
019	.05	.034	.016
020	.15	.041	.109
021	.25	.264	-.014
022	.20	.061	.139
023	.05	.041	.009
024	.20	.215	-.015
026	.25	.307	-.057
027	.20	.315	-.115
028	.23	.230	.000
029	.15	.036	.114
030	.10	.143	-.043
031	.15	.142	.008
			= 1.322

MEAN = .0456
STD DEV = .0748
n = 29

TABLE XXIX

Technical Merit (6.3 Projects)

Case	Subjective Weights	Regression Weights	Difference
002	.15	.073	.077
003	.25	.660	-.041
004	.25	.351	-.101
005	.20	.376	-.176
006	.10	.061	.039
007	.10	.011	.089
008	.05	.078	-.028
009	.20	.257	-.057
010	.10	.042	.058
011	.03	.008	.022
012	.15	.103	.047
013	.25	.445	-.195
014	.20	.275	-.075
015	.24	.149	.091
016	.20	.395	-.195
017	.40	.672	-.272
018	.15	.212	-.062
019	.22	.302	-.082
020	.15	.069	.081
021	.20	.380	-.180
022	.15	.112	.038
023	.50	.707	-.207
024	.20	.360	-.160
026	.10	.040	.060
027	.25	.315	-.065
028	.18	.179	.001
029	.05	.044	.006
030	.20	.218	-.018
031	.30	.491	-.191
			= -1.865

MEAN = -.0643
STD DEV = .1236
n = 29

TABLE XXX

Resource Availability (6.3 Projects)

Case	Subjective Weights	Regression Weights	Difference
002	.05	.129	-.079
003	.18	.002	.178
004	.10	.033	.067
005	.15	.102	.048
006	.20	.168	.032
007	.20	.338	-.138
008	.20	.078	.122
009	.10	.024	.076
010	.10	.051	.049
011	.15	.090	.060
012	.09	.001	.089
013	.20	.198	.002
014	.10	.012	.088
015	.09	.007	.083
016	.15	.087	.063
017	.15	.099	.051
018	.10	.020	.080
019	.15	.086	.064
020	.10	.102	-.002
021	.10	.001	.099
022	.10	.005	.095
023	.05	.001	.049
024	.10	.074	.026
026	.10	.110	-.010
027	.10	.027	.073
028	.12	.065	.055
029	.10	.064	.036
030	.05	.000	.050
031	.10	.007	.093
			= 1.499

MEAN = .0517
STD DEV = .0577
n = 29

TABLE XXXI

Likelihood of Success (6.3 Projects)

Case	Subjective Weights	Regression Weights	Difference
002	.05	.008	.042
003	.17	.010	.160
004	.15	.052	.092
005	.10	.015	.085
006	.10	.091	.009
007	.15	.011	.139
008	.15	.106	.044
009	.10	.039	.061
010	.20	.141	.059
011	.20	.177	.023
012	.04	.005	.035
013	.05	.001	.049
014	.15	.012	.138
015	.14	.017	.123
016	.10	.000	.100
017	.15	.099	.051
018	.25	.102	.148
019	.17	.034	.136
020	.20	.373	-.173
021	.05	.001	.049
022	.10	.000	.100
023	.10	.008	.092
024	.15	.074	.076
026	.20	.177	.023
027	.15	.132	.018
028	.12	.065	.055
029	.15	.044	.106
030	.40	.060	.340
031	.15	.003	.147
			= 2.333

MEAN = .0804
STD DEV = .0799
n = 29

014	.20	.383	-.183
015	.40	.705	-.305
016	.00	.013	-.013
017	.15	.066	.084
018	.40	.921	-.521
019	.40	.699	-.299
020	.10	.127	-.027
021	.25	.154	.096
022	.25	.200	.050
023	.20	.404	-.204
024	.25	.446	-.196
025	.23	.152	.078
026	.10	.102	-.002
027	.20	.076	.124
028	.35	.366	-.016
029	.30	.407	-.107
030	.15	.088	.062
031	.25	.210	.040
032	.24	.349	-.109
033	.01	.059	-.049
034	.20	.222	-.022
035	.20	.155	.045
036	.30	.519	-.219
037	.25	.251	-.001
038	.15	.088	.062
039	.13	.039	.091
040	.15	.019	.131
041	.30	.445	-.145
042	.22	.122	.098
043	.30	.168	.132
044	.40	.577	-.177
045	.20	.252	-.052

TABLE XXXII

Time Period (6.3 Projects)

Case	Subjective Weights	Regression Weights	Difference
002	.15	.073	.077
003	.10	.022	.078
004	.10	.063	.037
005	.15	.087	.063
006	.20	.243	-.043
007	.05	.057	-.007
008	.05	.078	-.028
009	.10	.012	.088
010	.10	.061	.039
011	.07	.033	.037
012	.02	.005	.015
013	.10	.001	.099
014	.15	.025	.125
015	.05	.023	.027
016	.05	.020	.030
017	.05	.022	.028
018	.00	.062	-.062
019	.16	.109	.051
020	.05	.041	.009
021	.10	.006	.094
022	.20	.179	.021
023	.05	.001	.049
024	.10	.036	.064
026	.05	.059	-.009
027	.10	.027	.073

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TABLE XXXIII

Air Force Need (6.3 Projects)

Case	Subjective Weights	Regression Weights	Difference
002	.30	.516	-.216
003	.20	.267	-.067
004	.15	.150	.000
005	.30	.406	-.106
006	.30	.330	-.030
007	.30	.467	-.167
008	.40	.626	-.226
009	.30	.664	-.364
010	.30	.548	-.248
011	.30	.399	-.099
012	.44	.665	-.225
013	.25	.291	-.041
014	.30	.668	-.368
015	.29	.731	-.441
016	.40	.462	-.062
017	.05	.053	-.003
018	.30	.503	-.203
019	.25	.435	-.185
020	.35	.373	-.023
021	.30	.349	-.049
022	.25	.642	-.392
023	.25	.243	.007
024	.15	.241	-.091
026	.30	.307	-.007
027	.20	.184	.016
028	.29	.422	-.132
029	.50	.747	-.247
030	.20	.539	-.339
031	.25	.351	-.101
			= -4.409

MEAN = -.1520
STD DEV = .1321
n = 29

APPENDIX I

T-Test of the Comparisons for the Management Levels and Divisions

This appendix includes the test for both the 6.2 and 6.3 projects with respect to the management levels and divisions. Each test had the following hypothesis:

$$H_o: \mu_A - \mu_B = 0$$

where

μ_A and μ_B represent the mean relative weights of the management levels or divisions being compared.

Reject H_o if $t > t_{\alpha/2}$ at the .05 level of significance.

$$t_{n-1,\ \alpha/2} = t_{\infty,\ .025} = 1.96$$

TABLE XXXIV

T-Test of the Comparisons for the Divisions (6.2 Project)

Divisions Being Compared	Factor t Values					
	Cost-Benefit Ratio	Technical Merit	Resource Availability	Likelihood of Success	Time Period	Air Force Need
FX/FG	-1.70	7.93	.28	-11.28	1.35	-4.05
FX/FE	-3.39	23.25	4.72	3.62	6.46	-22.25
FX/FB	5.68	8.96	-.04	-6.86	3.91	-9.77
FG/FE	-1.32	13.13	3.96	12.95	4.97	-15.27
FG/FB	6.59	2.09	-.25	6.48	2.59	-5.73
FE/FB	8.71	-8.34	-3.43	-9.50	-1.94	7.00

TABLE XXXV

T-Test of the Comparisons for the Management Levels (6.3 Project)

Management Levels Being Compared	Factor t Values					
	Cost-Benefit Ratio	Technical Merit	Resource Availability	Likelihood of Success	Time Period	Air Force Need
CS/ST	-6.95	10.28	-15.71	-11.26	-27.96	1.56
CS/DIV	-7.59	1.64	-16.56	-9.48	-7.63	2.11
CS/BR	-12.68	6.32	-13.96	-17.08	-15.51	3.12
CS/GR	-12.35	3.49	-17.06	-16.20	-13.63	2.09
ST/DIV	2.20	-19.87	10.10	9.50	19.74	.78
ST/BR	-2.71	-14.81	8.66	5.17	-8.38	2.93
ST/GR	-.50	-29.08	10.00	7.92	8.63	.88
DIV/BR	-6.11	9.77	-2.00	-11.00	-13.17	1.92
DIV/GR	-3.83	3.98	-.24	-6.01	-6.98	-.07
BR/GR	2.93	-8.75	1.85	6.67	10.66	-2.66

CS = Command Section
ST = Staff
DIV = Division
BR = Branch
GR = Group

TABLE XXXVI

T-Test of the Comparisons for the Divisions (6.3 Project)

Divisions Being Compared	Factor t Values					
	Cost-Benefit Ratio	Technical Merit	Resource Availability	Likelihood of Success	Time Period	Air Force Need
PX/PG	2.63	8.44	3.62	3.81	-6.49	-11.40
PX/PE	-5.01	19.57	4.36	-6.64	.08	-11.00
PX/PB	3.66	13.37	4.21	2.83	-4.71	-13.54
PG/PE	-16.91	9.93	.12	-11.10	7.32	-.73
PG/PB	1.90	3.77	.98	-.85	-.65	-4.94
PE/PB	21.15	-8.09	.98	10.37	-4.94	-3.75

Vita

Terry L. Brooks was born in Rock Hill, South Carolina on 7 August 1951, the son of Leon M. Brooks and the late Anne R. Brooks. He graduated from Rock Hill High School in 1969 and attended Clemson University, Clemson, South Carolina. He graduated from there in 1973 with a Bachelor's Degree in Ceramic Engineering and a commission in the United States Air Force.

After completing Undergraduate Pilot Training at Webb Air Force Base, Texas in 1974, he was assigned as a T-38 Instructor Pilot and remained at Webb. In 1976, he was assigned to Ellsworth Air Force Base as an Aircraft Maintenance Officer. He entered the Air Force Institute of Technology in May 1978 to work towards a Master of Science degree in Systems Management. He has attended both Land and Water Survival Schools, the Accelerated Aircraft Maintenance Officer Course, Squadron Officer's School, and Ground Safety School.

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